TITLE: Hand Tools and Hardware I

EDUCATIONAL BLOCK 0.13.a

NOTES:
1. For the electrician, some of these tools may need to be skipped such as wire wrapper, riveters, and alignment tools.
2. This block should include sharpening and dressing of tools when applicable.
3. Hand tools is intended to include electric and pneumatic tools as needed.

REFERENCES:
1. Duarte, Salvador R., and Duarte, R. L. Electronics Assembly and Fabrication.
2. Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Demonstrate proficiency with common hand tools by selecting, properly using, and caring for the tools needed in performing typical jobs.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME
Properly use common hand tools in the assembly-disassembly of electronic, electrical and electromechanical equipment.	Screwdrivers Types Standard Blade Phillips Cross-Head S Screw Holding, etc. Nut Drivers Pliers Longnose Curved Nose Slip-Joint Gas Side Cutters Fuse and Tube Pullers Vise Grip Wrenches Box End Open End Sockets Adjustable Allen Riveters Chisels Torque Wrench Levels	8 hrs.
Properly use common hand tools in the construction and modification of electronic, electrical and electromechanical hardware systems.	Saws Hacksaw Sabre Saw Hole Saw Drills Electric Hand Rotary Impact	8 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Punches Socket Knockout Center Hammers Files Rules and Layout Tools Nibblers and Snips Taps and Dies Vises Clamps Wire Stripper Knives Crimpers Wire Wrappers	
Identify common screw sizes and types.	Screws Types Sheetmetal Machine Threads Sizes	8 hrs.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Show pictures, slides, etc. of different tools.

TITLE: Tools III (Electronic) EDUCATIONAL BLOCK 0.13.c

NOTES: 1. Some of these tools may be used by the electrician.

2. The usage of these tools can best be illustrated when teaching the skills which require them.

3. Time does not include student usage.

REFERENCES: Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Select and use the correct electronics hand and power tools.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Properly use common hand tools in making electrical connections.	Wire Strippers Knives Crimpers Wire Wrappers	1 hr.
Select and use specialized tools used in electrical, electronic equipment maintenance and repair.	File Card Board Extenders Alignment Tools Gozinta Air Hoses Vacuum Cleaners Tape Head Cleaners Test Clips	2 hrs.
Identify common electronic hardware.	Grommets Standoffs Rubber Feet Terminals Terminal Strips Silicone Compounds Potting Adhesive Greases Knobs Plugs, Jacks and Binding Posts Coaxial Connectors Printed Circuit Connectors	2 hrs.

SUGGESTED PROCEDURE:

1. Use illustrations to show the physical characteristics of the tool.

2. Use the tools when demonstrating the applicable skills.

3. Use electronic parts catalogs. Typical catalogs are:
   Newark Electronics, Chicago, Illinois
   Allied Electronics, Elgin, Illinois

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Soldering Skills

EDUCATIONAL BLOCK 0.50

NOTES: This block can be placed just about anywhere in an educational sequence so long as it proceeds any construction or repair activities.

REFERENCES:
1. Herrick, Clyde. Assembly Techniques.
2. Illinois Bell Film Library. Soldering.
3. Solder -- It's Fundamentals and Usage

GENERAL OBJECTIVE: Properly install and remove electrical/electronic components employing suitable soldering equipment and techniques.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the purposes and characteristics of the proper solder joint.	Mechanical Support of Components Minimal Resistance Appearance Smooth Shiny Proper Amount of Solder	2 hrs.
	Soldering Standards Industry NASA Military	2 hrs.
Use wire strippers, knives, and side cutters to strip insulation from typical wires and cables without nicking the conductor.	Plastic Covered Wire Cloth Covered Wires Solid Conductor Wires Stranded Conductors Co-axial Cables	6 hrs.
Properly tin conductors and terminals to assure perfect solder joint.	Application of Heat Application of Solders	1 hr.
Connect and wrap leads and terminals to provide sufficient mechanical support to components to be mounted.	Wrapping Crimping Wire Wrap	2 hrs.
Select the right soldering iron for typical soldering jobs in electrical-electronic systems.	Sufficient Heat and Dangers of Overheating Wattage Heavy Soldering Soldering to Terminals Soldering to PC Boards	2 hrs.
	Care and Dressing of Soldering Tips	1 hr.
Select the proper solder and fluxes for given soldering task.	Ratios of Solder Types of Flux Functions of Flux Cleaners	1 hr.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Properly apply heat, flux, and solder to form perfect solder joint.	Application of Heat to Lead Solder Flow Holding Components Heat Sinks Cooling	4 hrs.
Unsolder components from hand-wired as well as printed circuits without damage to circuit or circuit components.	Application of Heat Dangers of Over-Heating Avoidance of Splatter Techniques of Solder Removal Braid Solder Suckers Use of Soda Straw	2 hrs.
Identify special techniques of soldering encountered in electrical/electronic systems.	Grounded Tip Irons Variable Heat Irons Soldering Large Gauge Wire Solder Forms Soldering Compounds Solder Wave Baths Dip Soldering	2 hrs. 5 hrs.

SUGGESTED PROCEDURE:

1. For this block, it is recommended that the instructor obtain scrap components, PC boards, terminal strips, wires, etc., available at minimal cost as scrap from sources such as local industry, surplus outlets, etc. These can then be mounted so as to provide a wide range of typical conditions under which soldering is to be done.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Breadboard and Prototype Construction

EDUCATIONAL BLOCK 0.29

NOTES: It may be, due to cost and time considerations, that much of the sheet metal work in this block must be eliminated. It is, however, important that the student have experience in the layout, preparation, and construction of PC boards. These can be made with a minimum of equipment and materials costs.

REFERENCES:
1. Duarte, Salvador R. and Duarte, R. L. Electronics Assembly and Fabrication.
2. Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Breadboard and construct prototype circuits from sketches, schematic diagrams, and blueprints, using conventional materials, techniques and components.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the various breadboarding systems employed by industry.	Breadboarding Systems Commercial Systems PC Boards with Pads Cardboard Vector Board	2 hrs.
Layout sheet metal chassis following conventional methods and procedures.	Chassis Types Chassis Layout Component Location Allowances for Heat Dissipation Shielding Bend Allowances	4 hrs.
Construct sheet metal chassis and mount parts following conventional techniques.	Chassis Construction and Parts Mounting Cutting Bending Spot Welding Fasteners Nibbling Riveting Hole Punching Heat Sinking Socket Mounting PC Board Mounting Techniques Vertical Horizontal Rack Shock Mounting	10 hrs.
Wire chassis and components following standard practices.	Wiring Techniques Lead Dress Terminal Strips Cable Lacing Wire Wrapping Harness Construction Flat Cable	3 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Layout and construct printed circuit boards, using a minimum of space and following standard procedures and techniques.	Printed Circuit Techniques Types of Boards Methods of Production Taping Photographic Resist Silk Screen Layout of Circuit, Routing Etching Drilling Component Mounting	18 hrs.
Layout and construct control panels following standard methods.	Control Panel Layout	4 hrs.
Prepare a bill of materials and obtain needed parts.	Materials Sources Electronic Parts Houses	2 hrs.

SUGGESTED PROCEDURE:

1. If cost is a consideration in the implementation of this block, the instructor is reminded of the availability of stick-on etch resistant tape, and that cleaning and etching of boards can be done in flat cake pans. This allows for the production of PC boards at a minimum cost per unit.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electronic Assembly Skills — EDUCATIONAL BLOCK 0.70

NOTES: This block should be preceded by Blocks 0.29 and 0.50.

REFERENCES:
1. Duarte, Salvador R., and Duarte, R. L. Electronics Assembly and Fabrication.
2. Oregon State Board of Education. Electricity-Electronics Occupational Cluster Guide.
3. Ritchie, George L. Electronics Construction Techniques.

GENERAL OBJECTIVE: Perform those skills necessary to properly assemble electronic equipment systems.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Construct assemblies from pictorial diagrams or sample unit.	Printed Circuit Boards Single Sided Double Sided Baby Boards	2 hrs.
Use production line test jigs.	Jigs Types Usage	2 hrs.
Use automatic component insertion machines.	Insertion Machines Automatic Semi-Automatic	2 hrs.
Use automatic soldering machines.	Soldering Machines Automatic Semi-Automatic	2 hrs.
Prepare and lace cables.	Harness Diagrams Harness Jigs Lacing Cable	2 hrs.

SUGGESTED PROCEDURE:

1. Use pictures from catalogues or trade magazines to illustrate different machines.

2. Use surplus printed circuit boards for illustration.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Logs and Reports

EDUCATIONAL BLOCK 0.26

NOTES: The instructor should choose which section of this block is applicable to the occupation being covered. For example, the broadcast engineer may need only the material on F.C.C. logs.

REFERENCES: Pauley, Stephen. Technical Report Writing Today.

GENERAL OBJECTIVE: Keep clear, concise records of work performed and communicate this information to others using conventional methods and form.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Keep accurate records of laboratory or shop activities as performed.	Lab Notebook Dated Pages Entries Statement of Intentions Diagrams Curves, Data, Specs, Etc. Observed Data Effect of Modifications Calculations Results and Conclusions	2 hrs.
	Job Sheets Time In and Out Work Done Materials Used Cost of Materials Rates on Time Totals	4 hrs.
Communicate technical information by writing technical reports on experiments, products, design, etc., following accepted forms.	Technical Reports Specification Sheets Process Descriptions Technical Directions and Procedures	8 hrs.
Keep complete and proper logs on equipment, making appropriate entries when necessary, including broadcast, public safety and commercial radio installations.	Log Entries FCC Rules and Regulations Form of Entries When to Make Entries Who May Make Entries Correction to Entries Filling of Logs	2 hrs.

SUGGESTED PROCEDURE:

1. Use worksheets, time cards and OSHA forms such as those included in the Appendix.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: AC Motors and Alternators

EDUCATIONAL BLOCK I.18

NOTES: This block is intended to cover single and three phase motors and alternators.

REFERENCES:
1. Adams, James E. Electrical Principles and Practices.
2. Allis Chalmers. A Guide to Care of Electrical Motors.
3. McIntyre, R. L. Electric Motor Control Fundamentals.
4. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
5. Rosenberg, Robert. Electrical Motor Repair.
6. State of Maine Department of Education. Industrial Electricity Curriculum Manual.

GENERAL OBJECTIVE: Install, remove, connect and perform minor repairs on AC motors and alternators.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
State the principles and sketch the circuits for the different types of AC motors and alternators.	Types of AC Machines Split Phase Motors Capacitor Polyphase Synchronous Shaded Pole Series Alternators	16 hrs.
Connect or wire single and three phase motors in accordance with blueprints or name plates.	Name Plate Data Voltage Current Wiring Diagram KVA	2 hrs.
Reverse a motor by changing the leads.	Motor Rotation Principles	1 hr.
Test a motor for shorts and grounds.	Motor Repair Tools Growler VOM	2 hrs.
Check and replace motor capacitors.	Motor Capacitors Uses Running Starting Types Oil Electrolytic Dry Voltage Rating Capacitance Rating	2 hrs.
Check and change centrifical switches.	Centrifical Switches Type Ratings	2 hrs.
Check, clean and replace brushes.	Commutator and Brushes	2 hrs.
Check bearings.	Lubrication Alignment	2 hrs.

SUGGESTED PROCEDURES:

1. Pictures of typical motors and installations would be useful.
2. Use illustrations from references #2, #3, and #4 and equipment catalogs from General Electric, Westinghouse, Emerson, Dayton and Allis Chalmers, or other typical manufacturers.
3. Assemble and disassemble an AC motor.
4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Motor Repair and Overhaul

EDUCATIONAL BLOCK I.23

NOTES: 1. The scope of this block is all rotating devices up to 100 h.p. or as handling capabilities will allow, i.e., machines requiring special handling equipment should not be covered.

2. This block can be done in conjunction with Block I.12 and I.13.

REFERENCES:
1. Adams, James E. Electrical Principles and Practices.
2. A Guide to the Care of Electrical Motors.
3. Anderson, Edwin P. Electric Motor Guide.
4. Lytel, Allan H. ABC's of Electric Motors and Generators.
5. Mages, Loren J. Electric Generating Systems.
6. Rosenberg, Robert. Electric Motor Repair.
7. Schweitzer. Fractional Horsepower Motors and Repair.
8. Smeaton, Robert. Motor Application and Maintenance Handbook.

GENERAL OBJECTIVE: Overhaul, rebuild and repair rotating electrical devices.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Check, lubricate and/or replace bearings.	Bearings Roll Sleeve Ball Rotor Shafts End Plates Lubricants Oils Greases Method of Applying Oil or Grease	2 hrs.
Replace Brushes.	Brushes Function Motors That Use Brushes Grades Sizes Shades Material	2 hrs.
Replace or adjust centrifugal switches.	Centrifugal Switches Function Motors That Use Switches Sizes Types Ratings Location	2 hrs.
Rewind stator, rotor and field windings.	See Reference #6, Electric Motor Repair	8 hrs.
Test pole piece polarities.	Pole Piece Polarities Function Types of Tests	1 hr.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Balance rotors and reassemble motor with proper end loading or end play.	Bearings End Plates	4 hrs.
Test windings, components and connections for shorts, grounds and opens.	Visual Inspection Resistance Readings Test Points Ohms Intermittant	2 hrs.
Replace defective parts such as wire, capacitors, connectors and cables.	Wire Types Coils Insulation Mounting Capacitors Type Oil Electroyltic Function	4 hrs.
Repair and adjust small motors.	Small Motors Types Vibrating Printed Circuit Stepping Universal	4 hrs.
Use motor test equipment and tools listed in the outline.	Growler Internal External Test Light Coil Winders Compass Undercutter	4 hrs.

SUGGESTED PROCEDURE:

1. Obtain and use faulty motors for the students to practice their trouble-shooting techniques.

2. Use motors to demonstrate repairing and lubricating techniques.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

ACKNOWLEDGEMENTS:

Doran Hershberger, General Electric, DeKalb, Illinois.

TITLE: Audio-Visual Skills

EDUCATIONAL BLOCK 0.23

NOTES: Material in this block should be augmented with work on audio-visual equipment in the school.

REFERENCES:
1. Brown, Lewis Hacleroad. AV Instruction: Media and Methods.
2. Manufacturer's Equipment Manuals and Instruction Books.
3. Middleton, Robert G. Tape Recorder Servicing Guide.
4. Oates, Stanton C. Audio Visual Equipment.
5. Pula, Fred J. Application and Operation of Audiovisual Equipment in Education.
6. Wyman, Richard. Mediaware: Selection, Operation, Maintenance.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install permanent and temporary sound and video systems.	Codes Public Rooms Auditoriums Stages Open Wire Techniques Enclosed Wire Techniques	2 hrs.
	Component Placement Microphones Speakers Control Boards Amplifiers Patch Boards Acoustics	4 hrs.
	Cable Preparation Patch Cords Audio Cable Control Wires Connectors and Terminals	1 hr.
Properly interconnect equipment	Termination Grounding Impedance Matching	2 hrs.
Mix P.A. music and projector systems to provide desired multi-media effect.	Timing Tape Control Cues Fading Automatic Projector Control Special Effects Lighting	4 hrs.
Troubleshoot electronics, electric, and electromechanical equipment to locate fault and replace or repair.	Audio-Visual Equipment Phonographs Projectors Tape Machines Recorders TV Monitors Cameras Video Tape Machines	16 hrs.

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Audio Systems

EDUCATIONAL BLOCK 0.22

NOTES: Time as recommended herein does not include practical experience as outlined in the suggested procedure.

REFERENCES:
1. Brown, Lewis Hacleroad. AV Instruction: Media and Methods.
2. Nisbett, Alec. The Technique of the Sound Studio for Radio, Television and Film.

GENERAL OBJECTIVE: Install, operate and maintain theatre (live) audio systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install audio systems in and on public rooms, auditoriums and stages.	Audio Systems Fixed Portable Components Speakers Microphones Amplifiers Patch Panels Tape Recorders Audio Cable Control Location for: Speakers Microphones Location	24 hrs.
Place microphones and speakers to avoid accoustic problems and to produce special audio effects.	Accoustics Cross Coupling Feedback Dead Spots Mixing	4 hrs.
Install audio system per specifications and in accordance with applicable codes.	Installation Location Portable Fixed Patch Panel Function Wiring Diagram Codes Electrical Wiring	6 hrs.
Match impedances of cable and components.	Impedance Matching Purpose Function Pads	1 hr.
Operate stage and auditorium audio systems in accordance with script, manager and action cues. Assist in planning and producing recording sessions for stage and music production.	Control Room Layout Control Panel Master Mixers Patch Panel Recorders	10 hrs.
	Sound Cues Script Stage Manager Action	2 hrs.

SUGGESTED PROCEDURE:

1. Have the student work with or for student sponsored theatre groups. Again it should be emphasized that the student must have an appreciation for the theatre and an understanding of stage plays.

2. Practical or hands-on experience is not included herein but would be gained by working on a school production.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements III

EDUCATIONAL BLOCK 0.19.a

NOTES: Instruments and Measurements (I.19.a) is a prerequisite to this block. The topics covered in this block might best be covered as needed rather than as a block in itself.

REFERENCES:
1. Manufacturer's Instruction Manuals
2. Training and Retraining, Inc. Understanding and Using Test Instruments.

GENERAL OBJECTIVE: Select, use properly, and care for instruments and test equipment used in troubleshooting electronic systems.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of signal generators (both AF & RF), signal tracers, capacitor checkers, transistor testers, logic probes and test jigs and fixtures.	Instrument Characteristics Capabilities of Each Accuracy Reading Scales Sensitivity Care of Instruments Calibration	4 hrs.
Apply and trace a signal through an electronic system with the equipment listed.	Signal Generators Audio Frequency Radio Frequency Sweep Generators	2 hrs.
Determine the condition of transistors, vacuum tubes, and integrated circuits found in electronic systems.	Transistor Testers Tube Testers IC Checkers Logic Probes	2 hrs.
Identify bad or leaky capacitors, inductors, and determine their value with maximum accuracy.	Capacitor Checkers Bridges	1 hr.
Properly use special test jigs and fixtures in evaluating electronic system components.	Test Jigs and Fixtures Extender Boards Special Extender Cables Soldering Fixtures	1 hr.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Use equipment manuals. Typical manufacturers are:
   Henlett Packard, Palo Alto, California.
   Tektronix, Beaverton, Oregon.
   Sencore Inc., Soux Falls, South Dakota.

TITLE: R.F. Systems I

EDUCATIONAL BLOCK 0.27.a

NOTES: See troubleshooting guides in Appendix for techniques.

REFERENCES:
1. Grob, Bernard and Kiver, Milton. Applications of Electronics.
2. Lemons, Wayne. Transistor Radio Servicing Course.
3. Shrader, Robert. Electronic Communications.
4. Zbar, Paul B. Basic Radio: Theory and Servicing.

GENERAL OBJECTIVE: Operate, troubleshoot and align radio receivers, including AM and FM broadcast as well as communications equipment.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Demonstrate his knowledge of radio receivers by constructing block diagrams of typical types showing the signal processing performed by each block.	AM Receivers R.F. Amplifiers Tuning Circuits Converters (Mixers) I.F. Amplifiers Detectors Grid Leak Plate Diode Regenerative Amplifiers A.V.C. FM Receivers R.F. Amplifiers Tuning Circuits Converters I.F. Amplifiers Discriminators Ratio Detector Phase Slope Detection Tuning Indicators A.F.C. FM Stereo (Multiplex) S.C.A. (Store Cast) Pre-Emphasis De-Emphasis Audio Amps	20 hrs. 30 hrs.
Tune and align AM, FM, FM-Stereo and communications receivers following standard procedures.	Signal Injection Order of Tuning Adjusting AGC	5 hrs.
Tune receivers to antennas.	Antenna Types Tuning	1 hr.
Troubleshoot and align miniature receivers.	Mobile Receivers Transceivers C.B. Units	5 hrs.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements IV

EDUCATIONAL BLOCK 0.19.b

NOTES: Prerequisite to this block are Blocks I.19.a, and O.19.a.

REFERENCES:
1. Lemons, Wayne. Transistor Radio Servicing Course.
2. Manufacturer's Instruction Manuals.
3. Shrader, Robert L. Electronic Communication.
4. Zbar, Paul B. Basic Radio: Theory and Servicing.

GENERAL OBJECTIVE: Select, use properly and care for specialized instruments used in checking, aligning, and troubleshooting radio frequency electronic systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of frequency counters, grid-dip meters, RF power meters, RF sweep generators, distortion analyzers, dummy loads, special test and calibration equipment and test jigs and fixtures.	Instrument Characteristics Capabilities of Each Accuracy Scales and Dials Loading Effects Sensitivity Care of Instruments Calibration	6 hrs.
Measure frequency of RF signals with the full accuracy and precision of the instruments listed.	Grid Dip Meters Frequency Counters Oscilloscope	3 hrs.
Measure RF power levels and SWR with the full accuracy and precision of the instruments listed.	RF Power Meters Watt Meters	1 hr.
Analyze RF Waveforms.	Distortion Analyzer	1 hr.
Align and troubleshoot RF systems by signal injection techniques.	RF Signal Generator Sweep Generators	2 hrs.
Properly use dummy loads, and special equipment in aligning and troubleshooting RF equipment.	Dummy Loads Special Test Equipment (as applies to specialized equipment) Special Calibration Equipment Test Jigs and Fixtures	4 hrs.

SUGGESTED PROCEDURES:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

2. Demonstrate different measuring techniques.

TITLE: Alignment and Calibration

EDUCATIONAL BLOCK 0.28

NOTES: This block covers electronic meters and test equipment as well as TV and radio receivers. Also included is TV convergence.

REFERENCES:
1. Equipment Manufacturer's Manuals and Instruction Books.
2. Lemons, Wayne. Transistor Radio Servicing Course.
3. Tinnell, Richard W. TV Symptom Diagnosis, An Entry into TV Service.
4. Zbar, Paul B. Basic Radio: Theory and Servicing.

GENERAL OBJECTIVE: Be able to calibrate and align electronic test equipment and radio and TV receivers.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Test, align, and calibrate electronics test equipment using manufacturer's drawings and specifications and known frequency and voltage standards.	Test Equipment Oscilloscope VTVM VOM Counters Signal Generators	4 hrs.
Align receivers using a sweep generator and oscilloscope.	Radio Receivers AM FM FM-Stereo FM Stereo Multiplexer Television B & W Color CB Short Wave	2 hrs.
Converge a color television set using a color bar/dot generator.	Color TV Convergence Hi Voltage Adjust Purity Static Convergence Gray Scale Dynamic Convergence	2 hrs.

SUGGESTED PROCEDURE:

1. Use manufacturer's data for alignment and calibration.

2. Use existing lab test equipment to demonstrate calibration.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instruments and Measurements V

EDUCATIONAL BLOCK 0.19.c

NOTES: Prerequisites to this block are Blocks I.19.a, 0.19.a, 0.20.a, and 0.20.b.

REFERENCES:
1. Deane, Leslie D. and Young, Calvin C., Jr. TV Servicing Guide.
2. Tinnell, Richard W. TV Symptom Diagnosis.

GENERAL OBJECTIVE: Select, use properly, and care for specialized instruments used in checking, aligning, and troubleshooting television systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the salient features and characteristics of vector scopes, TV analysts, test jigs and fixtures, dot and bar generators, picture tube testers, high voltage probes and tuner substitutes.	Instrument Characteristics Capabilities of Each Accuracy Scales and Dials Loading Effects Sensitivity Care of Instruments Connection of Gear Calibration	4 hrs.
Identify faulty circuit(s) and components in television systems.	Signal Generation and Injection TV Analyst IF Signals UHF Signals VHF Signals Audio Signals Color Signals Picture Signals Color Burst Signals Sync Signals Horizontal Sweep Signals Vertical Sweep Signals	6 hrs.
	Waveform Checking - Oscilloscope	2 hrs.
	Testing Flyback Transformers and Yokes TV Analyst High Voltage Probes	1 hr.
	Testing Picture Tubes Picture Tube Tester Test Fixtures	1 hr.
	Analyzing Color Circuits Vector Scope TV Analyst	2 hrs.
	Converging Color Sets Dot and Bar Generators	4 hrs.
	Aligning TV Sets Sweep Generators TV Analyst	2 hrs.
	Tuner Checking Tuner Substitutes	1 hr.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook, Irving W. Larson, ed.

TITLE: R. F. Systems II (Transmitters) EDUCATIONAL BLOCK 0.27.b

NOTES: A First Class FCC License is required to sign the station log.

REFERENCES: Chicago Board of Education. Curriculum Guide for Occupational Electronics.

GENERAL OBJECTIVE: Operate, tune, and troubleshoot radio frequency transmission equipment in accordance with accepted procedures as outlined by the federal communications rules and regulations.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Demonstrate his knowledge of transmitters by constructing block diagrams of typical types showing signal processing performed by each block.	AM Transmitters Power Supplies Amplifiers Oscillators Buffers Power Amplifiers Modulators and Modulation Theory High Level Low Level Drivers and Exciters Emission Classifications	30 hrs.
	FM Transmitters Power Supplies Amplifiers Oscillators Frequency Multipliers Buffers Power Amplifiers Modulators Direct (FM) Phase Modulators Pulse Modulation Keying System Emission Classifications	30 hrs.
Tune, operate, and troubleshoot transmitters.	Tolerances (F.C.C.) Frequency Power Modulation Tuning of Transmitters Neutralization F.C.C. Operating Rules Techniques of Troubleshooting Reading and Logging of Meters and Monitors	15 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Describe the characteristics and applications of common transmission lines.	Transmission Lines Types Impedance Matching VSWR VSWR Meters Time Domain Reflectometers	8 hrs.
Describe the characteristics and applications of common antenna systems.	Antenna Systems Single Directional Impedance Patterns Gain Amplifiers Tuning Couplers Splinters Baluns Traps Alternators Taps	20 hrs.

SUGGESTED PROCEDURE:

1. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: FCC First Class Commercial License

EDUCATIONAL BLOCK 0.25

NOTES: 1. There are many excellent study guides, Q & A manuals and texts for use in preparing for the license in addition to the study materials available from area FCC engineering offices at a nominal cost.

2. Second and first class is probably beyond the high school level.

REFERENCES: 1. Kaufman, Milton. Radio Operators License Q & A Manual.
2. Shrader, Robert. Electronic Communications.

GENERAL OBJECTIVE: Demonstrate knowledge of FCC rules and regulations as well as knowledge of radiotelephone systems by passing the FCC First Class Test.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Pass Third Class FCC Commercial Radiotelephone License Test. Pass Second Class FCC Commercial Radiotelephone License Test. Pass First Class FCC Commercial Radiotelephone License Test.	Element I Basic Law Element II Basic Operating Practice Element III Basic Radiotelephone and Troubleshooting DC Circuit Elements and Theory AC Theory Inductance and Transformers Capacitors AC Circuits Resonance and Filters Electron Tubes Solid State Devices Motors and Generators AC Power Supplies Meters and Scopes Oscillators and Multivibrators H.F. Amplifiers R.F. Amplifiers Transmitters, AM and FM Receivers, AM and FM Antennas and Transmission Lines Frequency Measurement Microwave Rules and Regulations Element IV Advanced Radiotelephone Television Broadcast - Commercial Rules and Regulations	60 hrs.

SUGGESTED PROCEDURE:

1. This unit should serve as a capstone to a sequence in radio electronics to be offered in the senior year of high school if at all.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Instrumentation Systems

EDUCATIONAL BLOCK 0.31

NOTES: This block includes the total instrumentation system from transducer to recorder and includes skills other than electronic. Many of these skills are required of the electrical appliance serviceman and some are beyond the scope of a high school program.

REFERENCES:
1. A. E. Staley Manufacturing Company, Decatur, Illinois.
2. Considine, Douglas M. Process Instruments and Controls Handbook.
3. Norton, Harry N. Handbook of Transducers for Electronic Measuring Systems.
4. O'Higgins, Patrick J. Basic Instrumentation, Industrial Measurement.
5. Sentz, Robert E. and Bartkowiak, R. A. Feedback Amplifiers and Oscillators.

GENERAL OBJECTIVE: Install, connect, calibrate, troubleshoot and read instrumentation systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify the major parts of an instrumentation system--transducer, amplifier and recording instrument.	Transducers To be Measured Temperature Attitude Pressure Displacement Flow Light Intensity	2 hrs.
Install and Connect: Cut, bend, flare and solder instrument tubing; Install fittings for instrument tubing; Drill and tap holes and nuts; Cut and thread machine screws and instrument piping; Paint instrument housing and covers; Make manometers; Make thermocouple leads; Repair air valves; Anneal tubing.	Principle Capacitive Inductive Resistive Photovoltaic Piezoelectric	2 hrs.
	Type Thermister Gyro Potentiometers Thermocouples Crystals Photovoltaic	4 hrs.
	Sensing Element	
	Amplifiers Direct Couples DC Low Level Power Differential Digital Feedback	4 hrs.
	Recording Instruments Analog Meters Strip Charts Indicator Lights	4 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Tape Recorders Circular Recorders	
	Control Systems Open Loop Close Loop Analog Digital Automatic Semi-Automatic Synchos	8 hrs.
Calibrate and Troubleshoot: Perform a leak test with a liquid; Clean, assemble, calibrate and test instrumentation equipment as stated in the outline.	Basic Equipment Pneumatic and Electric Relays Selector Valves Positioners Recorders and Indicators Including Transmitters and Receivers Level Controllers Pressure Switches Solenoid Valves Pressure Gauges Dial Thermometers Control Drives and Linkage Control Valve Diaphrams Transducers Computer Hardware Conductivity Cells Ph Cells Flowmeters Pressure and Temperature Indicator CO_2 and Oxygen Recorders Level Indicators Level Recorders Pressure and Temperature Recorders Manometers Electronic Tubes Portable Vibrometers Integrators Gas and/or Oil Firing Pressure Regulators Weightometers Vacuum Recorders and Indicators Timers and Clocks Meters Alarms and Annunciators as Applies to Section Combustion Controls	16 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Three Element Lead Controls Superheat and De-superheat Controls Level Controls on Heaters, Sumps, Tanks, Etc. Water Treatment Controls Damper Controls Pump Controls Pulverizer Controls Hydrogen Controls Coal Feeder Controls Temperature Controls Fan Speed Controls Feed Water Controls	

SUGGESTED PROCEDURE:

1. Many of these skills can be illustrated using refrigeration, air-conditioning and heating controls from old or wreck units.

2. Tour to local industries.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Plumbing

EDUCATIONAL BLOCK I,64

NOTES: Time permits little practical application and many of these skills could be considered in the job training.

REFERENCES:
1. Manas, Vincent. National Plumbing Code Handbook.
2. Matthias, A. J., and Smith, Estes. How to Design and Install Plumbing.
3. Oravetz, Jules, Sr. Plumbers and Pipe Fitters Library.

GENERAL OBJECTIVE: Install and connect electrical/electronic equipment that require water and waste disposal connections as well as fuel supplies

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define common terms used in plumbing and identify common plumbing system components.	Terms and Definitions	2 hrs.
Install and modify waste disposal systems.	Drainage and Waste Sizes and Types Materials Traps Ventillation Installation Modification	4 hrs.
Install and modify hot and cold water supplies.	Water Supply Sizes Materials Iron Copper Plastic Installation Modification Fixtures Valves	4 hrs.
Install and connect equipment to gas and other fuel supplies.	Gas Connection and Fittings Fuel Oil Connection and Fittings	4 hrs.

SUGGESTED PROCEDURE:

1. Visit appliance repair shops.
2. Time will probably not allow for practical application and emphasis should be on demonstration.
3. Show pictures, slides etc. of typical installations.

TITLE: Install and Read Recording Instruments

EDUCATIONAL BLOCK I.31

NOTES: This block is intended for electric utility workers and instrument technician. The instructor must decide which areas are to be covered.

REFERENCES:
1. Howard Sams Technical Staff, ed. Instrumentation Training Course.
2. Ohio Trade and Industrial Education Service. Electric Lineman.
3. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Install, connect and read time recordings of voltage, current, power and other electrical parameters.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Connect magnetic tape recording meters to single and three phase circuits. Set up and operate magnetic tape recording meters. Load and unload magnetic tape recording meters.	Magnetic Recorders Power Input Input Connections Tape Reels Drive Mechanism Speed Setting	4 hrs.
Connect chart recording meters to single and three phase circuits.	Chart Recorders Circular Power Input Input Connections	2 hrs.
Set up and operate chart recording meters.	Charts Types Layout	2 hrs.
Load and unload charts.	Speed Setting	1 hr.
Connect recorders to measure voltage or current.		2 hrs.

SUGGESTED PROCEDURE:

1. Demonstrate recorder connection, set up, and calibration.

2. Obtain catalogs from recorder manufacturers. Typical manufacturers are: Bell and Howell Co., Pasedena, California; Ampex, Redwood City, California; and Teletype Corp., Skokie, Illinois.

3. Visit a laboratory or control room for some industrial process such as electric utility, water utility, chemical laborstory, etc.

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

ACKNOWLEDGEMENTS:

Robert Billing, Illinois Public Service Co., Champaign, Illinois.

TITLE: Drawings and Specifications (Electrical) EDUCATIONAL BLOCK I.11.a

NOTES: 1. Because of the preponderance of specialized terminology, abbreviations and acronyms in the electrical field, they should be pointed out and emphasized throughout the educational sequence.

2. This block is designed to include architectural drawings.

REFERENCES:
1. Graham, Kennard C. National Electrical Code and Blueprint Reading.
2. Heine, Gilbert M. How to Read Electrical Blueprints.
3. Sundberg, Elmer W. Building Trades Blueprint Reading, Part I.
4. The Wiring Diagram--How to Read It--Interpret It--Use It. (Casette Tape).

GENERAL OBJECTIVE: Read and interpret conventional drawings, schematics, blueprints and specifications encountered in electrical occupations.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify and describe conventional types of drawings, schematics, diagrams, graphs and charts encountered in electrical occupations.	Types of Drawings Block Diagrams Schematics Wiring Diagrams One-line Diagrams Three-line Diagrams Sketches System Map (Utilities) Pictorials Control Drawings Blueprints Architectural House Wiring Signal Wiring Motor and Generator Blueprints Graphs and Charts Bar and Pie Charts Volt-Ampere Graphs Characteristic Curves Nomographs	8 hrs.
Read and interpret standard electrical terminology, abbreviations and acronyms.	Glossary of Electrical Terms	1 hr.
Read and use standard electrical symbols and industrial variations.	Symbols Electrical Mechanical Architectural	4 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Read and interpret conventional drawings, diagrams and charts used in electrical occupations.	Conventions of Electrical Drawings Lines Lettering Title Blocks Notes Date and Revisions (change letter) Bill of Materials Model and Serial Number Block Diagrams Schematics One-line Drawings Three-line Drawings System Maps Production Drawings Control Drawings Architectural Drawings	1 hr.
Identify and describe standard types of specifications used in the electrical industry.	Specifications Types of Specifications Operating Performance Contractual Architectural Cost Test Installation	1 hr.
Read and interpret conventional specifications for electrical equipment.	Specifications Content Input Current Voltage Power Ripple Frequency Output Voltage Current Power Frequency Stability Accuracy Environmental Temperature Vibration Humidity Shock Mounting Specifications	4 hrs.
Draw sketches of electrical units, using conventional practices.	Sketching	2 hrs.
Read, use and follow manufacturer's assembly and operating instruc-	Manufacturer's Data Operating Manual Shipping Manual Assembly Instructions	2 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Operate a polaroid camera.	Polaroid Camers Configuration Operation	1 hr.
Locate replacement parts using supply house catalogs.	Supplier Catalogs Typical Examples	1 hr.

SUGGESTED PROCEDURE:

1. The instructor should have a wide assortment of different types of drawings, diagrams, specification sheets and blueprints so that the students get experience in reading as many of the types as possible.

2. The student should also obtain a complete glossary, dictionary of electrical terminology and a diagram of typical electrical symbols used in electrical diagrams. See appendix.

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Electrical Codes

EDUCATIONAL BLOCK I.12

NOTES: 1. This block should be taught both as a separate block and as an integral part of others as needed.

2. This block is organized around the national code and applicable variance as indicated by state and local codes should be included.

REFERENCES: 1. National Electrical Code.
2. Watt, John H. NFPA Handbook of the National Electrical Code.

GENERAL OBJECTIVE: Plan electrical circuits, purchase parts, and install electrical circuits and equipment in accordance with national, state, and local codes.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Define terminology used in codes properly.	Terminology of Codes (Article 100)	10 hrs.
Locate codes applicable to job to be done.	Code Organization and Structure (Article 110)	10 hrs.
Determine electrical codes and select proper breaker, wire, and service equipment and parts according to National Code Articles 200-280.	Wiring Design and Protection Use of Conductors Branch Circuits Feeders Services Overcurrent Protection Grounding Lighting Protection	40 hrs.
Select proper wiring methods for job according to National Code Articles 300-390.	Wiring Materials and Methods Temporary Wiring Conductors for General Wiring Continuous Rigid Cable Supports Open Wiring Sheathed Cables Entrance Cables Underground Cables Extensions Conduit and Tubing Raceways Wire Ways Flat Cable Bus and Cable Ways Boxes and Fittings Switches	30 hrs.
Wire equipment for general use according to National Electrical Code Articles 400-480.	Equipment for General Use Flexible Cords and Cables Flexible Wires Lighting Equipment	20 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Appliances Electrical Heating De-Icing and Snow Melting Motors, Motor Circuits and Controllers Air Conditioning and Refrigeration Generators Transformers Capacitors Resistors and Reactors Storage Batteries	
Wire special occupancies and special equipment under special conditions according to National Electrical Code Articles 500-555, 600-680, 700-750, and 800-820.	Special Occupancies Hazardous Locations Commercial Garages Residential Garages Hangers Service Stations Health Care Facilities Theaters, etc. Mobile and Recreational Vehicle Facilities Marinas	15 hrs.
	Special Equipment Signs and Lighting Cranes and Hoists Elevators and Escalators Welders Recording Equipment Data Processing Systems Organs X-Ray Equipment Industrial Tools	10 hrs.
	Special Conditions Emergency Systems Over 600 Volts Low Voltage (Under 50V) Remote and Signal Circuits Outside Circuits Stand-by Systems	10 hrs.
	Communications Systems Communication Circuits Radio and TV Equipment CATV	10 hrs.

SUGGESTED PROCEDURE:

1. Have students look up specifications for jobs in code book.
2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

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TITLE: Wiring I

EDUCATIONAL BLOCK I.13.a

NOTES: Wiring I covers rough wiring for non-metallic sheathed cable (Romex), armored cable and flexible conduit. Interior Wiring II will cover rigid and thin wall conduit.

REFERENCES:

1. Adams, James E. Electrical Principles and Practices.
2. Alerich, Walter N. Electrical Construction Wiring.
3. Croft, Terrill, et. al. American Electricians Handbook.
4. Graham, Kennard C. Interior Wiring - Residential.
5. Marcus, Abraham. Electricity for Technicians.
6. Mileaf, Harry. Electricity One-Seven.
7. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
8. Richter, Herbert P. Wiring Simplified.
9. Sears Roebuck Company. Simplified Electrical Handbook.
10. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Select and install common wiring systems.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install wiring boxes in or on floors, walls and surfaces.	Wiring Boxes Outlet Utility Sectional Switch Floor Pull Boxes	8 hrs.
	Box Accessories Covers Extension Rings	8 hrs.
	Surfaces (Interior and Exterior) Masonry 2 x 4 Studs Plaster Sheet Roll Wood Siding Aluminum Siding Steel Siding Vinyl Siding	8 hrs.
	Installation Hardware Staples Pipe Straps Toggle Bolts Beam Straps Wall Board Hangers Ground Rods Ground Clamps Hickeys	8 hrs.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Install a mast type or underground service entrance in or on surfaces as listed in the outline including meter box, ground rod and distribution panel.	Entrance Service Conduit Grounding Meter Box Entrance Panel Overhead Specification Clearance, etc.	6 hrs.
Install non-metallic sheathed cable from entrance panel to outlet box.	Non-Metallic Sheathed Cable Types (NM and NMC) Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	20 hrs.
Install greenfield (Flexible Conduit) from outlet box to electrical load.	Flexible Steel Conduit Types AC and MC Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	2 hrs.
Install low voltage wiring and components.	Low Voltage Systems Furnace Antenna Systems Intercom Door Bell	5 hrs.
Install armored cable from outlet box to electrical load.	Metal Clad Cable Types AC and MC Two Wire Three Wire Ground Wire Ampacity and Voltage Rating	2 hrs.

SUGGESTED PROCEDURE:

1. See Reference #10 for detailed steps.
2. Construct a 8 foot 2 x 4 wall and install service entrance, circuit breaker panel and outlets.
3. Use electrical equipment manufacturer's catalogs.
4. In conjunction with building construction, the class could wire a house. This would require additional time.
5. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Tools II (Electrical) EDUCATIONAL BLOCK 0.13.b

NOTES:
1. There are special tools required of the electrician which are not covered in Block 0.13.a.
2. Actual tool usage can be covered with the blocks as the skill is being presented.
3. Time does not include tool usage

REFERENCES: The Bending System, Republic Steel Corporation.

GENERAL OBJECTIVE: Select and use the correct electrical tools.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Select and use hand and power tools for installing conduit.	Rigid Conduit Power and Hand Benders Hand and Power Reamers Vise Hand and Power Threaders Thin Wall Hand Benders Reamers Crimpers Saws Hacksaw (Hand) Hacksaw (Power) Hole Saw Impact Wrench Pipe Cutter	12 hrs.

SUGGESTED PROCEDURE:

1. Use illustrations to show the student the physical characteristics of the tools.

2. Use the tools when demonstrating the skills of Blocks I.13.b.

3. Use material on conduit tools from Benfield Bender Co. and Rigid Tool Co. or other typical conduit tool companies.

4. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Wiring II

EDUCATIONAL BLOCK I.13.b

NOTES: 1. Wiring II covers thin wall and rigid conduit. Other wiring systems (open wiring, metal raceways, under floor raceways, bus duct, etc.) are not covered.

2. Conduit usage in this block is limited to two inch.

REFERENCES:
1. Bending the Bendfield Way.
2. Croft, Terrill, et. al. American Electricians Handbook.
3. Marcus, Abraham. Electricity for Technicians.
4. Mileaf, Harry. Electricity One-Seven.
5. Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.
6. Richter, Herbert P. Wiring Simplified.
7. USOE. Construction Occupations Curriculum Project.

GENERAL OBJECTIVE: Install common wiring systems including materials and devices.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Use a knockout punch for cutting holes in wiring boxes.	Wiring Boxes Outlet Utility Sectional Etc.	1 hr.
Mount electrical equipment cabinets, panels and boxes on various type surfaces as listed in the outline.	Electrical Equipment Cabinets Meter Cabinets Disconnect Cabinets Disconnect Switches Distribution Panel Starter Switches Branch Circuit Panel	12 hrs.
Mount and wire electrical controls.	Electrical Controls Float Switches Thermostats Pressure Switches	3 hrs.
Install surface metal raceway.	Surface Metal Raceway Types One Piece Two Piece Pancake Sizes Capacity Codes Fittings Wall Clips Elbows Switches Receptacles	2 hrs.
Cut rigid and thin wall conduit using hand and power cutters.	Conduit (Thin Wall and Rigid) Standard Lengths Standard Diameters Capacity	1 hr.

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Ream rigid conduit.	See Block O.13.b	5 hrs.
Thread rigid conduit using hand or power threaders.	See Block O.13.b	2 hrs.
Bend kicks, saddle and 90° bends in rigid conduit using power threaders.	See Block O.13.b	6 hrs.
Bend kicks, saddle and 90° bends in thin wall conduit using hand threaders.	See Block O.13.b	6 hrs.
Install conduit wiring boxes and panels in or on floors, walls and various type surfaces as listed in the outline.	Conduit Hardware Couplings Connectors Reducers Off Sets Conduit Toggle Bolts Pipe Straps Concrete Inserts Conduit Hangers Bushings Locknuts Explosion Proof	15 hrs.
Install wire in conduit.	Wire Solid Stranded Wire Material Sizes Ampacity Insulation	15 hrs.
Know and identify waterproof wiring systems.	Fixtures Hardware	

SUGGESTED PROCEDURE:

1. Reference Number 7 is a most complete reference available and is of sufficient detail to be very helpful.

2. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Rewire and Modify

EDUCATIONAL BLOCK I.45

NOTES: 1. This block would include single and three phase.

2. This block should be sequenced closely with Blocks I.13.a and I.13.b.

REFERENCES: Richter, Herbert P. Practical Electrical Wiring: Residential, Farm and Industrial.

GENERAL OBJECTIVE: Install in existing buildings in accordance with applicable code, new electric circuits and equipment.

SPECIFIC OBJECTIVES AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify location and path of new circuit.	Conduit Ducts Crawl Space Attic Hidden or Visible	2 hrs.
Identify method of installation.	Surface Metal Raceway	1 hr.
Identify need for increasing size of the service.	Estimate Load Existing New	2 hrs.
Identify new circuit breaker or fuse requirements. Identify new circuit capacity and wire size.	Electrical Load Size Distance	2 hrs.
Identify new circuit connection point.	Connection Points Entrance Panel Junction Boxes	4 hrs.
Identify and know the function of special tools and devices used for rewiring.	Tool and Devices Hanger Strips Surface Wire and Outlets Outlet Boxes with Compression Straps Extension Drills	6 hrs.
Identify and know the function of special rewiring techniques.	Wiring Behind Baseboards Wiring in Lath and Plaster Wiring in Wallboard Wiring in Two Story Structures Surface Wiring Installing Additional Circuits Installing Expanded Service Panel	6 hrs.

SUGGESTED PROCEDURE:

1. Using existing electrical plans have the student layout and size new circuits.

2. Use electrical devices and manufacturer's catalogs. Typical manufacturers are:
   Hubbell Wiring Devices, Bridgeport, Connecticut
   All-Steel Equipment, Aurora, Illinois
   Rawlplug Co., New Rochelle, New York
   General Electric, Providence, Rhode Island

3. Use media materials as listed in EIA - Electronics Multi-Media Handbook. Irving W. Larson, ed.

TITLE: Customer Relations/Job Orientation

EDUCATIONAL BLOCK 0.80

NOTES: Materials covered on this topic should be included as an on-going part of any program, as well as contained within this block of specific instruction.

REFERENCES:

1. Chapman, Elwood N., Your Attitude is Showing, (Science Research Associates: Chicago, Illinois), 1972.
2. Dubin, Robert, The World of Work; Industrial Society and Human Relations, (Prentice-Hall: Englewood Cliffs, New Jersey), 1958.
3. Personal Development for Young Men, 1st ed., (Instructional Materials Laboratory, Distributive Education Department, Division of Extension, University of Texas: Austin, Texas), 1967.

GENERAL OBJECTIVE: To identify the major components of interpersonal relations in a work situation.

SPECIFIC OBJECTIVE AND TOPICAL OUTLINE:

UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
Identify the major components of a work situation	Responsibilities of his specific job Overall structure of responsibility in the organization Structure of authority in the organization	1 hour
Identify informal components of a work situation	Informal groups Cliques Persons with shared technical interests Voluntary work groups Persons with shared backgrounds and education	1 hour
Identify the components of being a member of an organization	Goals of the organization Organization's role & function in the community Individual's position within the organization Necessary work contacts Immediate supervisor Co-workers Technical advisers Persons requiring supervision	1 hour

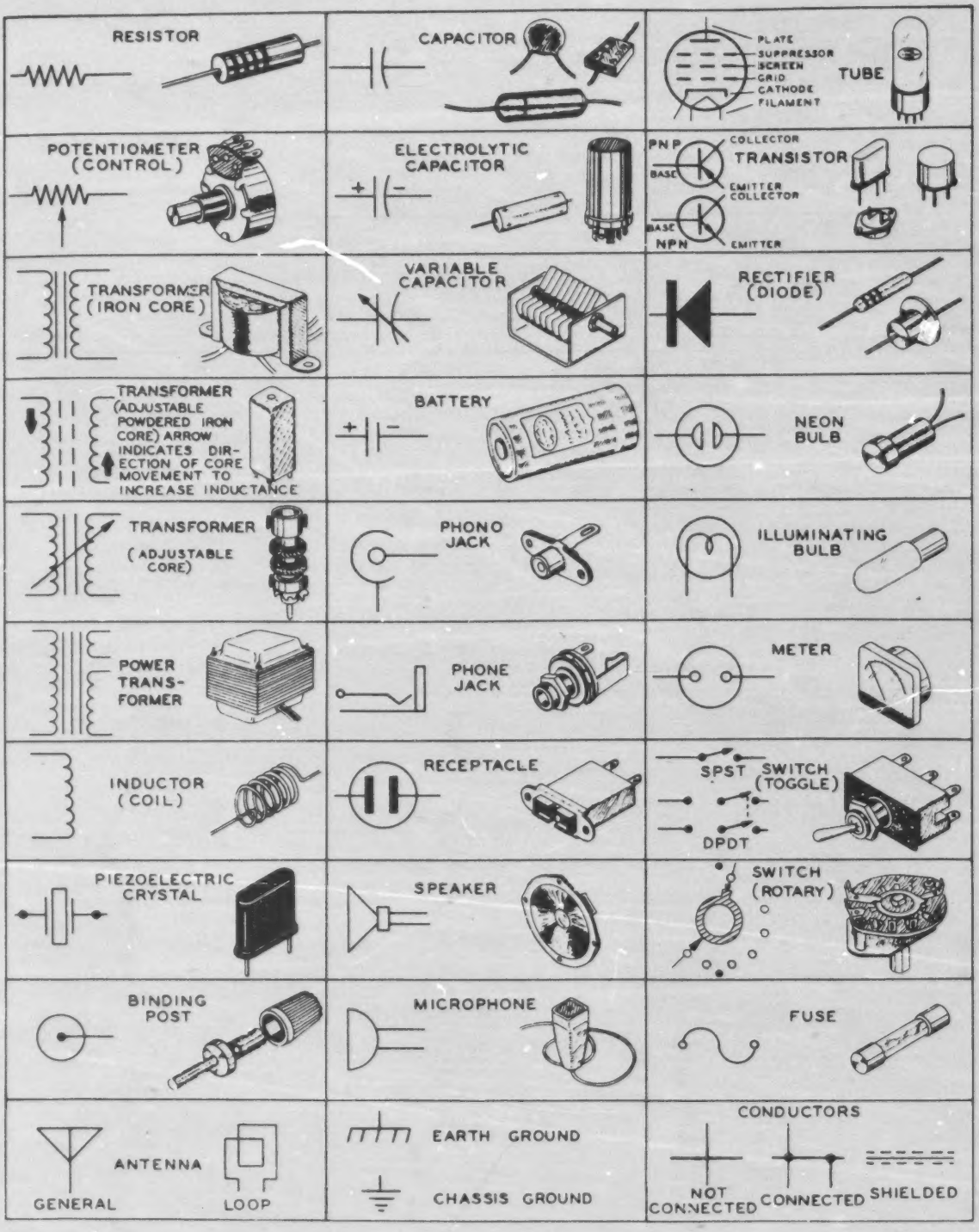
UPON COMPLETION OF THIS BLOCK, THE STUDENT WILL:	RECOMMENDED TOPICAL OUTLINE:	RECOMMENDED TIME:
	Anticipated relationships with persons outside of the organization Technical advisers Sources of parts & equipment Customers	
Identify appropriate work habits	Timeliness Neat appearance Pleasant demeanor	1 hour
Identify components of sound personal skills and behavior	Strong business vocabulary Descriptive words Effective speaking Pronounciation Voice tone Sincerity Poise Clarity Good personality over the phone Answering the phone Taking messages Transferring calls Giving information Speaking clearly, audibly Closing the phone conversation Good manners Positive attitude Cooperative point of view	2 hours

SUGGESTED PROCEDURE:

1. Provide the student with as much input from real-life work situations as possible: for example, arrange for visits by student groups to local businesses; bring past graduates of the school back to classroom to discuss the problems they encountered as new employees; provide talks by industrial representatives (e.g., personnel managers), from local businesses and industry on the qualities that they like to see in an employee.

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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GUIDE FOR READING AND DRAWING SCHEMATIC DIAGRAMS

A SCHEMATIC DIAGRAM:

1. shows the sequence of signal operations.
2. shows the dependence of each circuit block on neighboring blocks.
3. provides a pattern for troubleshooting the system.
4. provides a method for locating the parts on the chassis.
5. shows mechanical connections, linkages, or grouping of components.
6. shows external connections.
7. shows relative importance of components.
8. shows interconnection of components.
9. tells values and limitations of the components.

RULES TO FOLLOW WHEN READING OR DRAWING SCHEMATICS:

1. Signal flows from left to right.
2. Signal components (coupling) are generally connected horizontally.
3. Power flows up or down.
4. Power components are generally connected vertically.
5. All lines are drawn either horizontally or vertically, unless specifically required by the symmetry of the circuit.
6. Ground is always at the bottom.
7. All test points, components, connections, pin locations, etc., are labeled.
8. Overall symmetry must be upheld through:
   a. evenly spaced components
   b. similar components are placed at same level on the schematic
   c. parallel construction
   d. progressive construction
9. Standard symbols and conventions are used.
10. Function and importance of components and circuits are indicated through components placement and orientation.

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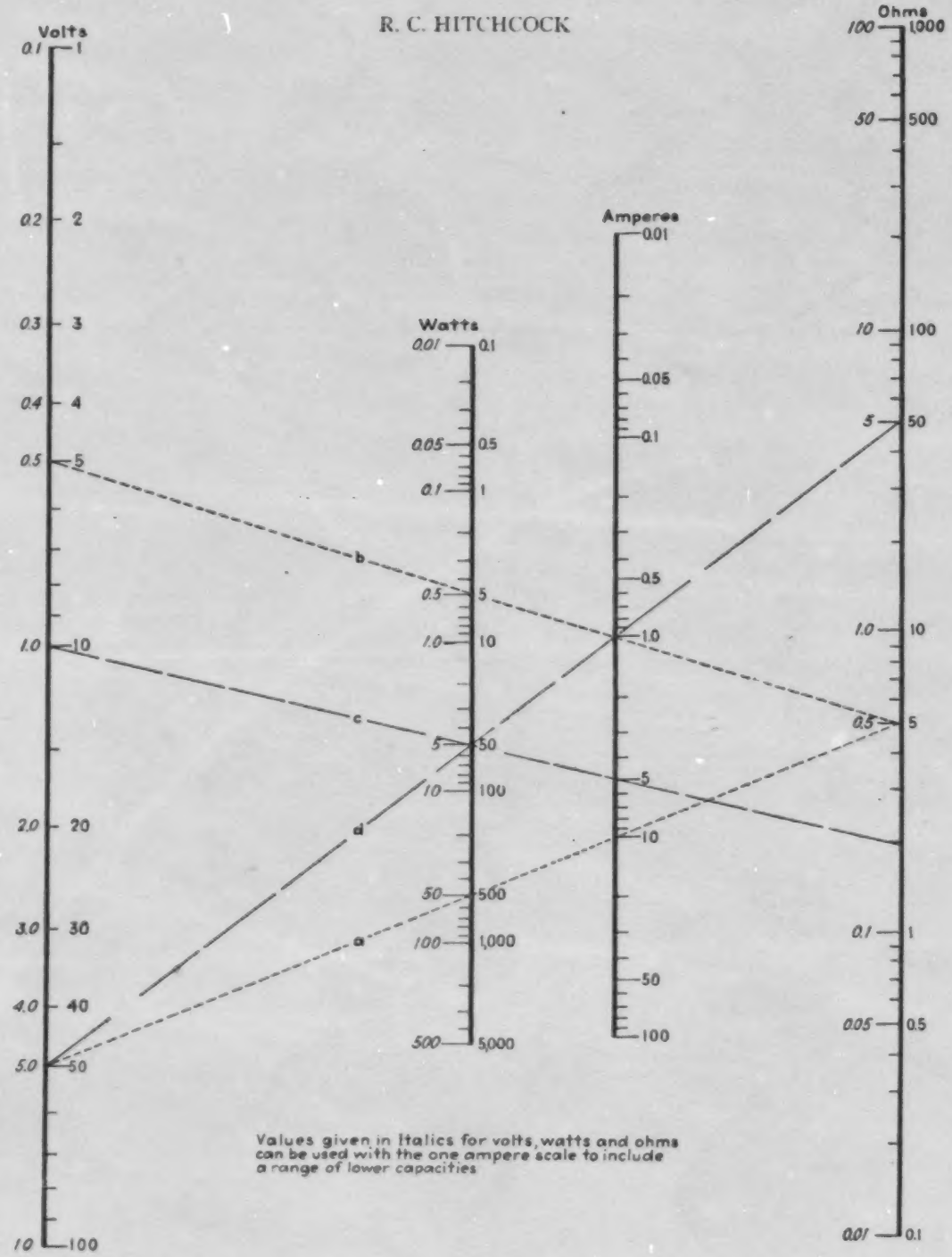
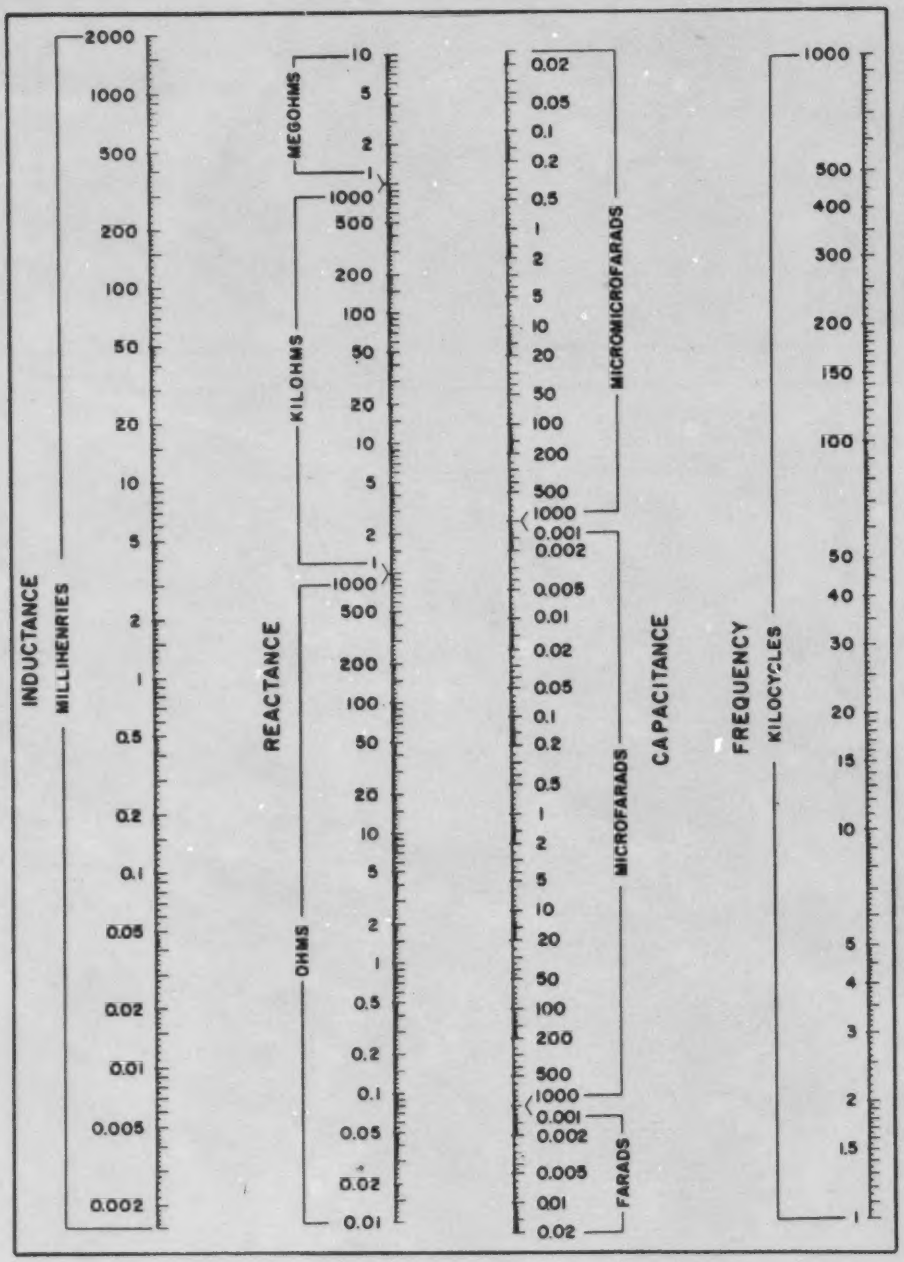
Chart for Solving Ohm's Equations

R. C. HITCHCOCK



Values given in Italics for volts, watts and ohms can be used with the one ampere scale to include a range of lower capacities

FREQUENCY-REACTANCE-CAPACITANCE-INDUCTANCE CHART (Cont)



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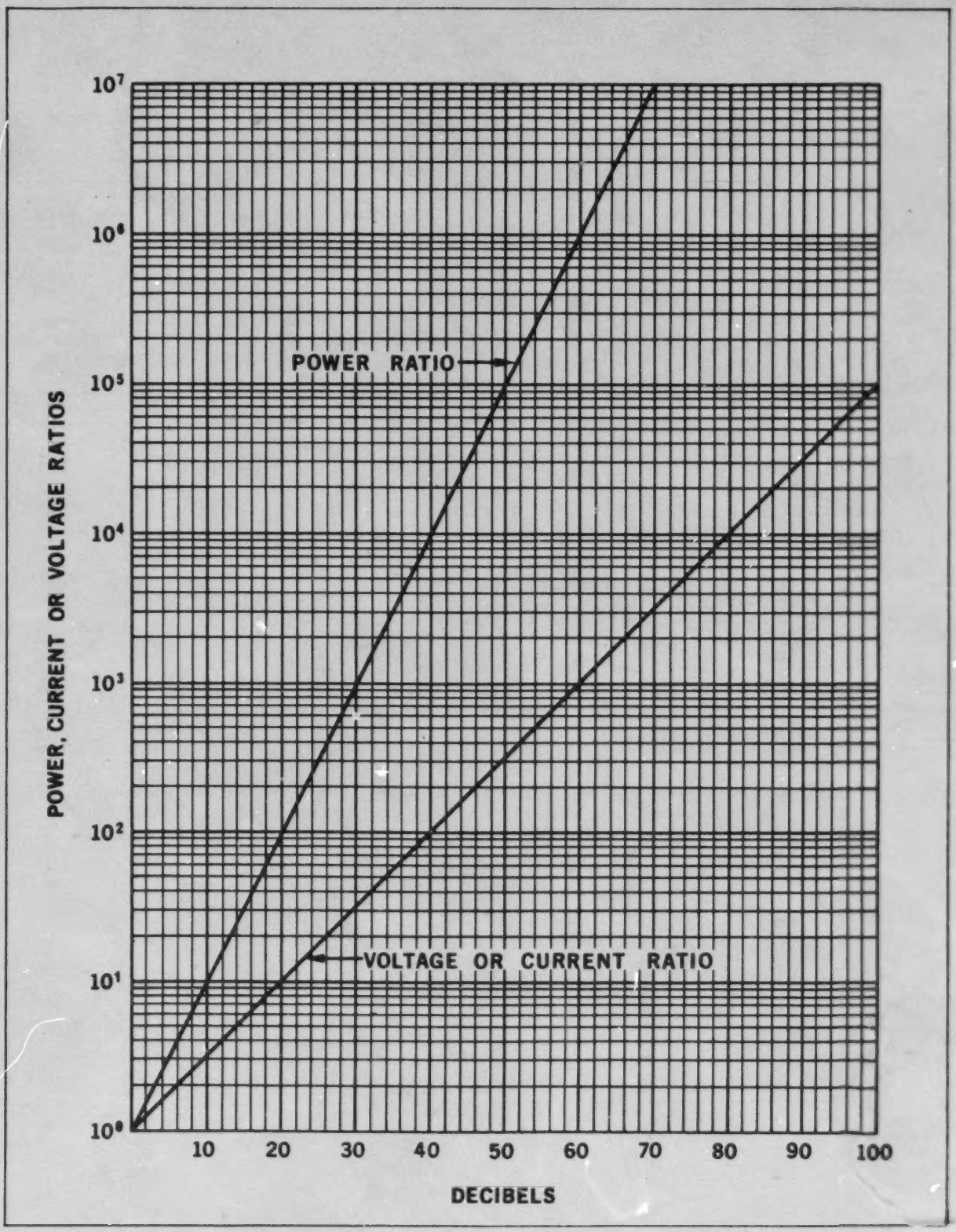

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Provided by Larry Mielcarz
Kankakee Area Career Center
Kankakee, Illinois 60901

OCCUPATIONAL SAFETY AND HEALTH ACT NOTES

Area or Equipment Inspected _____

Inspected by _____ Date _____

INSPECTION COMMENTS:

RE-INSPECTION REPORT

Area or Equipment Inspected _____

Inspected by _____ Date _____

INSPECTION COMMENTS:

REQUESTED BY
ADDRESS
CITY

CUSTOMER ORDER NO.	LOCATION	SERVICEMAN	DATE OF ORDER

MAINTENANCE ORDER

KACC ELECTRIC SERVICE

1st Call Date	serviceman	
T.T.	J.T.	T.T.

2nd Call Date	serviceman	
T.T.	J.T.	T.T.

Date _____ Signature _____

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material

Time

Date

Material Total

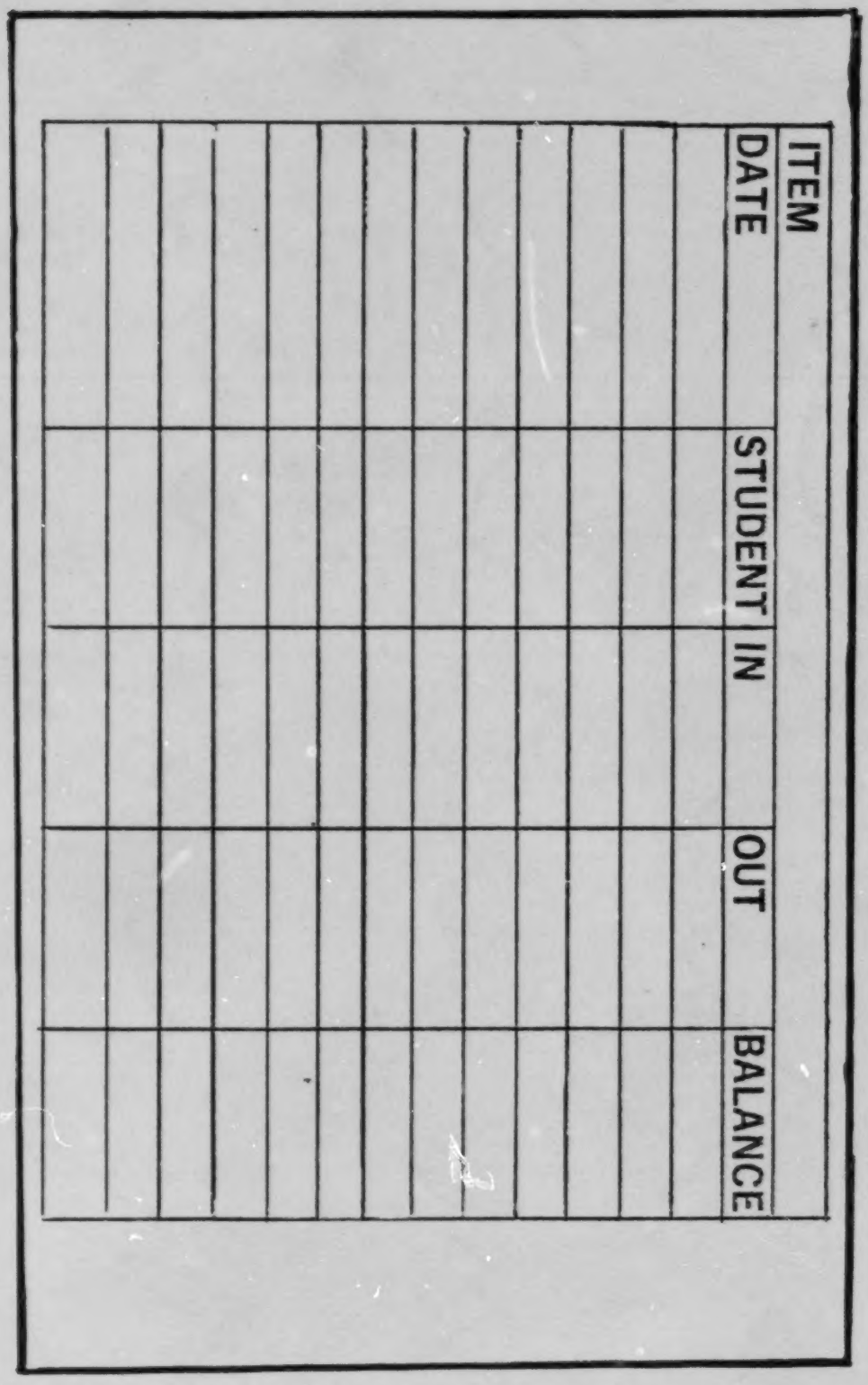
DAILY TIME TICKET

STUDENT:

TIME SLOT:

DATE:

Starting Time	Finishing Time	Job Description


ITEM
DATE
STUDENT
IN
OUT
BALANCE

WHAT YOU NEED TO KNOW TO TROUBLESHOOT!

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When an individual is beginning to learn how to troubleshoot, he may tend to go off in many different directions at once and become frustrated at not being able to solve electronic servicing problems except by a hit or miss process. To avoid this random guessing approach, the beginner needs guidance and direction in what he should know to troubleshoot effectively and efficiently. He needs to know how to proceed with his investigation once he has started. Many beginners look at a complicated piece of electronic equipment that contains 20 tubes or transistors, 200 or more capacitors and resistors, numerous transformers and diodes, and are awed and confused as what to do next. At this point many individuals are turned off by electronics because they feel they will never be able to work on anything that is so complicated. This author knows the feeling!

"You must crawl before you can walk" is an apt cliche at this point. By this it is meant that the individual should not tackle a complicated electronic system until he has mastered the circuits and he should not troubleshoot the circuits until he has a thorough knowledge of the components involved. He must also understand the relationship of the components to each other in the circuit and the relationships of the circuits to each other in the system.

There are some (including the author) that might say "This is all fine and good but I want to know where I'm supposed to go and how do I know when I get there in learning to troubleshoot?" The following is a general guide to troubleshooting that will aid the beginner in answering these questions and hopefully help to keep him on the right track when he starts to stray or become frustrated. This is meant to be an overview of troubleshooting in general and a guide to "how to proceed" with a complex system once the material

in this text has been mastered. In learning how to troubleshoot from the beginning, the material in the following chapters will be covered in an inverted order to this list. That is, the components will be covered first then the circuits that are made up of these components and then systems that are made up of these circuits.

A GENERAL GUIDE TO TROUBLESHOOTING: QUESTIONS AND EXPLANATION

The following is a general and practical guide to troubleshooting most problems that will occur in an electronic system. It may appear as though much of this information is common sense, but "common sense" is not very common anymore. The steps are arranged in what can be considered a logical sequence. The questions asked, are the questions that should be asked at that step in the troubleshooting so as to proceed in an orderly fashion and avoid chaos. The suggestions made are based on the premise that the problem or problems need to be solved by the simplest and most expedient method.

A General Guide to Troubleshooting: Questions

Step I. Learn the function of the system!

1. What does the system do?
2. How does the system perform its function?
3. How are the circuits of the system interrelated to perform the overall function of the system?

Step II. Identify the symptom!

1. What does the system not do that it should?
2. What does the system do that it should do?
3. Are there any symptoms that can be detected by the senses? (smell, touch, sight, hearing)
4. Have you seen the symptom before?

Step III. Isolate the problem area!

1. What areas can cause the symptom?
2. What areas do not affect the symptom?
3. Can a quick visual inspection detect the problem area?
4. What measurement or test will aid in locating the problem area?
5. What test equipment will be required?
6. Have you had this problem before?

Step IV. Stop and think!

1. Is everything very confusing at this point?
2. Should you clear your mind of any preconceived ideas?
3. Should you start over?
4. Are you jumping around from one area to another without following a logical pattern or a logical sequence of events?

Step V. Isolate the problem to a specific area!

1. What is the function of the area?
2. How does it perform its function?
3. Will a close visual inspection detect the problem?
4. What measurement or test will aid in locating the problem the quickest?
5. What test equipment will be required?
6. What is the function of each component in the area?
7. What can be bad about each component?
8. How can the component be checked?
9. What caused the component to become defective?
10. If an exact replacement component is not available is there a suitable substitute?
11. Does replacing or repairing the defect solve the problem?
12. Will the unit continue to operate to acceptable standards?

(Following is a more detailed version of the outline)

Step I. Learn the functions of the system!

1. What does the system do?

   A. A radio receiver converts electromagnetic energy at high frequencies into audio frequencies that can be detected by the ear.

   B. The television receiver converts electromagnetic energy at high frequencies into audio frequencies to which the ear can respond and to light impulses to which the eye can respond.

   C. The tape recorder converts intelligence that has been stored on magnetic tape into audio energy to which our ears can respond and the system must move the tape mechanically so as provide continuous intelligence.

2. How does the system perform its function?

   A. Amplifiers are used to increase the amplitude of signals.

   B. Oscillators must be used to generate a constant signal within the system.

   C. Mixers are sometimes used to combine signals.

D. Detectors are used to separate signals.

E. Waveshaping circuits are used to change or modify existing waveforms into a more useable form.

F. Transducers are used to convert one form of energy into another form. Voltage to accoustical energy.

G. Motors are used to cause mechanical movement.

H. Adjustments and controls are placed within the system to allow for tolerance interface between components and for component aging.

3. How are the circuits for the system interrelated to perform the overall function of the system?

A. Some stages depend on an input from a previous state and then send the output on to following stages. In other cases the output from a stage is sent back to previous stages for purposes of controlling the previous stages.

Step II. Identify the symptom!

1. What does the system not do that it should?

A. The system is completely dead and no performance can be detected.

B. The system is producing a noise but no intelligence.

C. The system has no or improper mechanical movement.

D. The system produces aural intelligence but no visual intelligence.

E. The system produces a visual but no aural intelligence.

F. The system produces all functions required but not to an acceptable standard.

G. The system produces functions that are at an acceptable standard but intermittently.

2. What does the system do that it should?

A. Many times by noting what the system does do, the stages that perform these functions correctly can be ignored. This is important because the more complex the system the more you can ignore when those stages are performing correctly.

3. Are there any symptoms that can be detected by the senses? (sight, hearing, smell, touch)

A. Perform a visual inspection of the system to locate any broken wires, burned or broker parts, signs of smoke, broken or cracked printed circuit boards, loose connections and hardware, and burned out vacuum tubes.

B. Listen for any strange noise such as arcing, howling, frying, and chattering.

C. Use the nose to detect any strange odors that indicate over-heated components such as resistors and transformers.

D. Touch the cases of transistors, transformers, electrolitic capacitors, and resistors for any unusually high temperatures. (Be careful of large transformers, resistors and some power transistors; these do have rather warm cases.)

4. Have you seen the symptom before?

A. Learn to categorize and relate various combinations of symptoms. This will aid in the future troubleshooting of similar systems and in turn reduce the time required for identifying all the symptoms and will enable you to better relate the symptoms to the problem.

Step III. Isolate the problem to a general area!

1. What areas can cause the symptom?

A. If the system is completely dead and a visual inspection indicates that the filament are not lit, then the only area that can cause this situation is the low voltage power supply.

B. If the turntable of a phonograph is not rotating, then this problem can be associated with either the power supply or the mechanical section of the system. This problem will not normally be associated with a defective amplifier unless of course the amplifier is overloading the power supply and causing it to become inoperative.

C. If the signal that is processed through the system is weak, then this would be an indication that there is lack of amplification and therefore checking the amplifiers would be a logical step to perform.

2. What areas do not affect the symptom?

A. If a television receiver has a good picture but poor or no sound signal, then only those stages that contain the sound signal need be checked and the stages that do not incorporate the sound signal can be ignored. Therefore in the more complicated systems, it is easier to locate the problem area by noting which of the areas of the system are functioning normally.

3. Can a quick visual inspection detect the problem area?

   A. In this case, the whole system is being visually checked and in the more complex systems, such as a color television, anything but a quick inspection (2 to 5 minutes) would involve a loss of time in troubleshooting. For example, an open capacitor or transistor cannot be spotted visually, but a broken wire, or burned out filament or a blown fuse is quick and easy to detect.

4. What measurement or test will aid in locating the problem area?

   A. The test or measurement to be made will depend somewhat on the system, the symptom, and test equipment available. In one case the signal injection method might be best, while in another case, signal tracing might be best suited for isolating the problem.

5. What test equipment will be required?

   A. It must be decided on the basis of what the symptom is and what equipment is available. The frequency and amplitude of a piece of test equipment must be taken into consideration for some applications. Some systems such as television may require special types of signals to apply to it in order to aid in troubleshooting. For some troubleshooting problems, it is best to have a visual output indicator rather than an aural indication. This would be especially true where waveforms are of prime importance as related to function performed.

6. Have you had this problem before?

   A. Many times previous experience with problems can help in guiding the troubleshooter to a likely trouble area because he has had the same type of problem before, especially if it is the same model or chassis that he has worked on before. Some particular models seem to have a weakness in one particular part of the system due to its design.

Step IV. Stop and think!

1. Is everything very confusing at this point?

   A. There are times in every technician's life when he tends to run around in circles and a solution to the problem evades him. This can be caused by having missed anyone of the steps above or having avoided a logical sequence of events up to this point. Sometimes a review of data collected, symptoms present, or measurements made will allow the technician to progress.

2. Should you clear your mind of preconceived ideas?

   A. Sometimes previous experience has taught us that a particular symptom is caused by a certain defect; but when that area is checked, it is found to be in good order. Once this has been determined leave that area alone. Too many times the technician is so convinced that the problem is in this area that he wastes time by continually returning to this area because he has a preconceived idea about the solution.

3. Should you start over?

   A. Interruptions and taking up troubleshooting where someone else left off or using data someone else has collected can lead a technician down the wrong path of analysis. In this case, it is best to start over.

4. Are you jumping around from one area to another without following a logical pattern or a logical sequence of events?

   A. This can be caused by either of items 1 and 2 above in this step or just one of those nervous and jumpy days that we all get.

Step V. Isolate the problem to a specific area!

1. What is the function of the specific area?

   A. Is it an amplifier, an oscillator, a power supply, or a signal splitter. Knowing the function will help in deciding what is not being performed properly.

2. How does it perform its function?

   A. Knowing how the area goes about performing its function will help to isolate which of the components in the area could cause such a problem. It will also alert the technician as to what to look for when making measurements and collecting data.

3. Will a close visual inspection detect the problem?

   A. At this point in isolating the problem, the technician only has a few components and a small area for concern. It may be a good idea to take a few minutes and closely inspect such items as cracked boards and components that might have been missed by the quick inspection.

4. What test equipment will be required?

   A. The test equipment required at this level may be different than it was when the problem was being isolated down to a general area. Here voltage measurements may be of great importance because this is what is reflected in the tech data.

Sometimes current measurements are given in the data; but to make such measurements, the circuit path must be broken and this is not always convenient to do. Therefore, a voltage measurement across a known resistance will yield the same information by simple computation.

5. What test equipment will be required?

   A. The loading effect of the test equipment may dictate which equipment is to be used. As to whether measurements can be made with power on or off may be another important factor.

6. What is the function of each component in the area?

   A. By knowing the component's function, it can be determined as to whether that particular component's being bad can cause the problem in that area.

7. What can be bad about each component?

   A. Shorted, open, leaky, increased or decreased value are various symptoms that a component can exhibit. Knowing the defect that a component can have, can alert the technician to what to look for in checking out that component.

8. How can the component be checked?

   A. A diode and sometimes a coil or transformer can be simply checked with an ohmmeter but it must usually be disconnected from the rest of the circuit. A capacitor can be checked sometimes with an ohmmeter (if it is 1 ufd or larger) but at other times it is best to use a capacitance checker if one is available. There is always the direct replacement method which is usually the best method if you don't wipe out the replacement in the process.

9. What caused the component to become defective?

   A. Many times a bad transistor may be found in a circuit and it is replaced with a new one, but a short time later it too becomes defective. This gets to be expensive. Therefore, when a component becomes defective, it may have done it on its own or another component's having become defective took the transistor or components with it. It is a good idea, in this case, to check the other components associated with the defective one.

10. If an exact replacement component is not available, is there a suitable substitute?

    A. The use of part substitution manuals can reduce the down-time on defective equipment. (It would be

terrible to have to send to Hong Kong or Tokyo for a transistor!) There are special cases where suitable substitutes will not work very well. Tubes are an example of this problem. Current requirements of the filament may be different and this would be fine in a parallel filament arrangement but not so good for a series strung set.

11. Does replacing or repairing the defect solve the problem?

    A. It could be that your analysis of the suspected part was wrong and it really wasn't bad and the problem still exists. There might be more than one problem.

12. Will the unit continue to operate to acceptable standards?

    A. Some repairs will correct the defect but the quality has decreased. This might be due to the interface of the new component to the older ones in the systems and alignment is called for. The poor quality could be caused by a suitable substitute being used that is not so suitable.

    B. Continued performance of the repaired unit is often neglected; because once a defective component is replaced, it is assumed that the problem is solved. Reviewing item 9 above, we find that maybe something caused the component replaced to become defective and until that something is corrected the unit cannot be considered to be totally repaired. The repaired unit should be operated under normal conditions for a period of time after the repair has been made.

The preceding outline and guide to troubleshooting is only meant to let the beginning troubleshooter know what he is in for when servicing electronic systems and circuits. As each of the succeeding chapters is covered, the individual should return to this outline/guide and review the appropriate area to see how the material covered fits into the overall logic of troubleshooting.

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Glossary

ABRASIVE: A material that cuts material that is softer than itself, such as emery, aluminum oxide and diamonds. It may be used in loose form, mounted on cloth, paper or bonded on a wheel.

ABSOLUTE SYSTEM: A system of numerically controlled machining that measures all coordinates from a fixed point of origin or zero point. Also known as point-to-point N/C machining.

ACCUMULATOR: A container in which fluid is stored under pressure as a source of fluid power.

ACTUATOR: A device for converting hydraulic energy into mechanical energy. A motor or cylinder.

ADDENDUM: The radial distance between the pitch circle and the top of the tooth.

ALCLAD: An aluminum alloy core with a thin coating of pure aluminum to prevent corrosion of the core metal.

ALLOWANCE: The intentional difference in the dimensions of mating parts to provide for different classes of fits.

ALLOY: A mixture of two or more metals fused or melted together to form a new metal.

ANNEAL: To soften metals by heating to remove internal stresses caused by rolling and forging.

ANODIZE: The process of protecting aluminum by oxidizing in an acid bath using a d-c current.

ARBOR: A shaft or spindle for holding cutting tools.

ASSEMBLY DRAWING: A drawing showing the working relationship of the various parts of a machine or structure as they fit together.

BACKLASH: The play (lost motion) between moving parts, such as threaded shaft and nut or the teeth of meshing gears.

BASIC DIMENSION: A theoretically exact value used to describe the size, shape or location of a feature.

BASIC SIZE: That size from which the limits of size are derived by the application of allowances and tolerances.

BEND ALLOWANCE: The amount of sheet metal required to make a bend over a specific radius.

BLANCHARDIZE: An operation which removes large amounts of stock through rotary grinding. Normally, it is a first operation for preparing castings for finish operations.

BLANKING: A stamping operation in which a press uses a die to cut blanks from flat sheets or strips of metal.

BORING: Enlarging a hole to a specified dimension by use of a boring bar. May be done on a lathe, jig bore, boring machine or mill.

BOSS: A small local thickening of the body of a casting or forging to allow more

thickness for a bearing area or to support threads.

BRAZE: To join two close fitting metal parts with heat and a filler material of zinc and copper alloy.

BROACH: A tool for removing metal by pulling or pushing it across the work. The most common use is producing irregular hole shapes such as squares, hexagons, ovals or splines.

BURNISH: To smooth or polish metal by rolling or sliding tool over surface under pressure.

BURR: The ragged edge or ridge left on metal after a cutting operation.

BUSHING: A metal lining which acts as a bearing between rotating parts such as a shaft and pulley. Also used on jigs to guide cutting tool.

CALLOUT: A note on the blueprint giving a dimension, specification or a machine process.

CAM: A rotating or sliding device used to convert rotary motion into intermittent or reciprocating motion.

CARBURIZE: The heating of low-carbon steel for a period of time to a temperature below its melting point in carbonaceous solids, liquids or gases, then cooling slowly in preparation for heat treating.

CASE HARDENING: The process of hardening ferrous alloy so that the surface layer or case is made much harder than the interior core.

CASTING: An object made by pouring molten metal in a mold.

CHECK VALVE: A valve which permits flow of fluid in one direction only.

CHOKE: A restriction, the length of which is large with respect to its cross-sectional dimension.

CIRCUIT: The complete path of flow in a hydraulic system including the flow-generating device.

CIRCUIT DIAGRAM: A line drawing using graphic symbols or pictorial views to show the complete path of flow in a hydraulic system.

CIRCULAR PITCH: The length of the arc along the pitch circle between the center of one gear tooth to the center of the next.

CLOSED LOOP: A system in which the output of one or more elements is compared to some other signal to provide an actuating signal to control the output of the loop.

COMMAND SIGNAL (or input signal): An external signal to which the servo must respond.

COMPONENT: A single unit or part.

CONCENTRIC: Having a common center as circles or diameters.

CONTOUR: The outline of an object.

CONTROL: A device used to regulate the function of a unit.

COOLER: A heat exchanger used to remove heat from the hydraulic fluid.

COUNTERBORE: The enlargement of the end of a hole to a specified diameter and depth.

COUNTERSINK: The chamfered end of a hole to receive a flat head screw.

DASH NUMBER: A number preceded by a dash after the drawing number that indicates right- or left-hand parts as well as neutral parts and/or detail and assembly drawings. The coding is usually special to a particular industry.

DATUM: A point, line, surface or plane assumed to be exact for purposes of computation from which the location of other features are established.

DEDENDUM: The radial distance between the pitch circle and the bottom of the tooth.

DESIGN SIZE: The size of a feature after an allowance for clearance has been applied and tolerances have been assigned.

DETAIL DRAWING: A drawing of a single part that provides all the information necessary in the production of that part.

DIE: A tool used to cut external threads by hand or machine. Also a tool used to

impart a desired shape to a piece of metal.

DIE-CASTING: A method of casting metal under pressure by injecting into metal dies of a die-casting machine. Also the part formed by die-casting.

DIE STAMPING: A piece cut out by a die.

DISPLACEMENT: The quantity of fluid which can pass through a pump, motor or cylinder in a single revolution or stroke.

DOWEL PIN: A pin which fits into a hole in an abutting piece to prevent motion or slipping, or to ensure accurate location of assembly.

DRAFT: The angle or taper on a pattern or casting that permits easy removal from the mold or forming die.

ECCENTRIC: Not having a common center. A device that converts rotary motion into reciprocating (back and forth) motion.

EFFECTIVITY: The serial number(s) of an aircraft, machine, assembly or part on which a drawing change applies. The change may be indicated as an effective date and would apply on that date forward.

ENCLOSURE: A rectangle drawn around a component or components to indicate the limits of an assembly. Port connections are shown on the enclosure line.

EXTRUSION: Metal which has been shaped by forcing it in the hot or cold state through dies of the desired shape.

FEATURE: A portion of a part, such as a diameter, hole, keyway or flat surface.

FEEDBACK (or feedback signal): The output signal from a feedback element.

FERROUS: Metals that have iron as their base material.

FILLET: A concave intersection between two surfaces to strengthen the area.

FILTER: A device whose primary function is the retention by a porous media of insoluble contaminants from a fluid.

FINISH: General finish requirements such as paint, chemical or electroplating rather than surface texture or roughness. (See surface texture.)

FIT: The clearance or interference between two mating parts.

FIXTURE: A device used to position and hold a part in a machine tool. It does not guide the cutting tool.

FLANGE: An edge or collar fixed at an angle to the main part or web as an I-beam.

FLAT PATTERN: A layout showing true dimensions of a part before bending. May be actual size pattern on polyester film for shop use.

FLUID:

1. A liquid or gas.
2. A liquid that is specially compounded for use as a power-transmitting medium in a hydraulic system.

FLUIDICS: A contraction of the words "fluid" and "logic," fluidics is a technology concerned with logical control functions and makes use of low pressure fluid interaction to produce control signals. Fluidic devices have no moving parts.

FORGING: Metal shaped under pressure with or without heat.

FORM TOLERANCING: Permitted variation of a feature from the perfect form indicated on the drawing.

FUSION WELD: The intimate mixing of molten metals.

GEOMETRIC DIMENSIONING AND TOLERANCING: A means of dimensioning and tolerancing a drawing with respect to the actual function or relationship of part features which can be most economically produced. It includes positional and form dimensioning and tolerancing.

GUSSET: A small plate used in reinforcing assemblies.

HARDNESS TEST: Techniques used to measure the degree of hardness of heat-treated materials.

HEAT EXCHANGER: A device which transfers heat through a conducting wall from one fluid to another.

HEAT TREATMENT: The application of

heat to metals to produce desired qualities of hardness, toughness and/or softness. (See anneal.)

HOBBING: A special gear cutting process. The gear blank and hob rotate together as in mesh during the cutting operation.

HONE: A method of finishing a hole or other surface to a precise tolerance by using a spring loaded abrasive block and rotary motion.

HORSEPOWER (HP): The power required to lift 550 pounds one foot in one second or 33,000 pounds one foot in one minute. A horsepower is equal to 746 watts or to 42.4 British thermal units per minute.

HYDRAULIC CONTROL: Control which is actuated by hydraulically induced forces.

HYDRAULICS: Engineering science pertaining to liquid pressure and flow.

INCREMENTAL SYSTEM: A system of numerically controlled machining that always refers to the preceding point when making the next movement. Also known as continuous path or contouring method of N/C machining.

INDICATOR: A precision measuring instrument for checking the trueness of work.

INTERCHANGEABILITY: The condition that assures the universal exchange or mutual substitution of units or parts of a mechanism or an assembly.

INVOLUTE: A spiral curve generated by a point on a chord as it unwinds from a circle or a polygon.

JIG: A device used to hold a part to be machined and positions and guides the cutting tool.

JOGGLE: A bend in a part to fit over other parts.

KERF: The slit or channel left by a saw or other cutting tool.

KEY: A small piece of metal (usually a pin or bar) used to prevent rotation of a gear or pulley on a shaft.

KNURL: The process of marking the surface of a part by rolling depressions in the surface.

LAP: To finish a surface with a very fine abrasive impregnated in a soft metal.

LIMITS: The extreme permissible dimensions of a part resulting from the application of a tolerance.

MAGNAFLUX: A nondestructive inspection technique that makes use of a magnetic field and magnetic particles to locate internal flaws in ferrous metal parts.

MAXIMUM MATERIAL CONDITION: When a feature contains the maximum amount of material, that is: minimum hole diameter and maximum shaft diameter. Abbreviated MMC.

MILL: To remove metal with a rotating cutting tool on a milling machine.

MISMATCH: The variance between depths of machine cuts on a given surface.

NEXT ASSEMBLY: The next object or machine on which the part or sub-assembly is to be used.

NOMINAL SIZE: A general classification term used to designate size of a commercial product.

NONFERROUS: Metals not derived from an iron base or an iron alloy base, such as aluminum, magnesium and copper.

NORMALIZING: A process in which ferrous alloys are heated and then cooled in still air to room temperatures to restore the uniform grain structure free of strains caused by cold working or welding.

ORTHOGRAPHIC PROJECTION: A multiview drawing that shows every feature of an object in its true size and shape.

PASSIVATION: Particularly applicable to stainless steel, it is a conditioning of the surface with a low strength nitric acid dip that develops the "stainless" property and prevents random staining due to "free iron" particles left from machining.

PICKLE: The removal of stains and oxide scales from parts by immersion in an acid solution.

PILOT: A protruding diameter on the end

of a cutting tool designed to fit in a hole and guide the cutter in machining the area around the hole.

PILOT HOLE: A small hole used to guide a cutting tool for making a larger hole. Also used to guide drill of larger size.

PILOT VALVE: An auxiliary valve used to control the operation of another valve. The controlling stage of a 2-stage valve.

PINION: The smaller of two mating gears.

PITCH: The distance from a point on one thread to a corresponding point on the next thread.

PLAN VIEW: The top view of an object.

PORT: An internal or external terminus of a passage in a component.

POSITIONAL TOLERANCING: The permitted variation of a feature from the exact or true position indicated on the drawing.

PROCESS SPECIFICATION: A description of the exact procedures, materials and equipment to be used in performing a particular operation such as a milling operation or spray painting.

PUMP: A device which converts mechanical force and motion into hydraulic fluid power.

QUENCHING: Cooling metals rapidly by immersing them in liquids or gases.

RAM: A single-acting cylinder with a single diameter plunger rather than a piston and rod. The plunger in a ram-type cylinder.

REAMING: To finish a drilled hole to a close tolerance.

RECIPROCATION: A straight line, back-and-forth motion or oscillation.

REFERENCE DIMENSION: Used only for information purposes and does not govern production or inspection operations.

REGARDLESS OF FEATURE SIZE (RFS): The condition where tolerance of position or form must be met irrespective of where the feature lies within its size tolerance.

RELEASE NOTICE: The authorization indicating the drawing has been cleared for use in production.

RELIEF VALVE: Pressure operated valve which bypasses pump delivery to the reservoir, limiting system pressure to a predetermined maximum value.

RESERVOIR: A container for storage of liquid in a fluid power system.

RESISTANCE WELDING: The process of welding metals by using the resistance of the metals to the flow of electricity to produce the heat for fusion of the metals.

RESTRICTION: A reduced cross-sectional area in a line or passage which produces a pressure drop.

ROTARY ACTUATOR: A device for converting hydraulic energy into rotary motion - - a hydraulic motor.

SANDBLAST: The process of removing surface scale from metal by blowing a grit material against it at very high air pressure.

SECTION: A cross-sectional view at a specified point of a part or assembly.

SENSOR: Devices which convert physical conditions into information which can be understood by the control system.

SEQUENCE:

1. The order of a series of operations or movements.
2. To divert flow to accomplish a subsequent operation or movement.

SERRATIONS: Condition of a surface or edge having notches or sharp teeth.

SERVO MECHANISM: A mechanism subjected to the action of a controlling device which will operate as if it were directly actuated by the controlling device, but capable of supplying power output many times that of the controlling device, this power being derived from an external and independent source.

SHIM: A piece of thin metal used between mating parts to adjust their fit.

SOLENOID: A coil of wire carrying an electric current possessing the characteristics of a magnet.

SPECIFICATION: A detailed description of a part or material giving all information not shown on the graphic part of the blueprint such as quality, size, quantity and manufacturer's name.

SPLINE: A raised area on a shaft (external) designed to fit into a recessed area of a mating part.

SPOT FACE: A machined circular spot on the surface of a part to provide a flat bearing surface for a screw, bolt, nut, washer or rivet head.

SPOT WELD: A resistance type weld that joins pieces of metal by welding separate spots rather than a continuous weld.

STRESS RELIEVING: To heat a metal part to a suitable temperature and hold that temperature for a determined time then cooled gradually in air. This treatment reduces the internal stresses induced by casting, quenching, machining, cold working or welding.

SUMP: A reservoir.

SUPERSEDENCE: The replacing of one part by another. A part that has been replaced is said to be superseded.

SURFACE TEXTURE: The lay, roughness, waviness and flaws of a surface.

TABULAR DIMENSION: A type of rectangular datum dimensioning in which dimensions from mutually perpendicular datum planes are listed in a table on the drawing instead of on pictorial portion.

TANGENT: A line drawn to the surface of an arc or circle so that it contacts the arc or circle at only one point.

TAP: A rotating tool used to produce internal threads by hand or machine.

TEMPERING: Creating ductility and toughness in metal by heat treatment process.

TEMPLATE: A pattern or guide.

TENSILE STRENGTH: The maximum load (pull) a piece can support without breakage or failure.

TOLERANCE: The total amount of variation permitted from the design size of a part.

TORQUE: The rotational or twisting force in a turning shaft.

TRANSDUCER (or feedback transducer): An element which measures the results at the load and sends a signal back to the amplifier.

TRUE POSITION: The basic or theoretically exact position of a feature.

TUMBLING: The process of removing rough edges from parts by placing them in a rotating drum that contains abrasive stones, liquid and a detergent.

TYPICAL (TYP): This term, when associated with any dimension or feature, means the dimension or feature applies to the locations that appear to be identical in size and configuration.

VERNIER SCALE: A small moveable scale attached to a larger fixed scale, for obtaining fractional subdivisions of the fixed scale.

WORKING DRAWING: A set of drawings which provide details for the production of each part and information for the correct assembly of the finished product.

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Standard Tables and Symbols

Decimal and Metric Equivalents

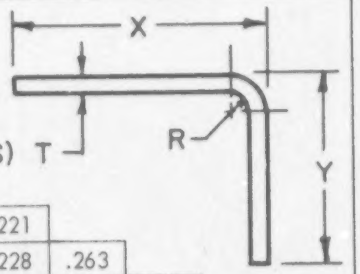
INCHES		MILLI-METERS
FRACTIONS	DECIMALS	
	.00394	.1
	.00787	.2
	.01181	.3
1/64	.015625	.3969
	.01575	.4
	.01969	.5
	.02362	.6
	.02756	.7
1/32	.03125	.7938
	.0315	.8
	.03543	.9
	.03937	1.00
3/64	.046875	1.1906
1/16	.0625	1.5875
5/64	.078125	1.9844
	.07874	2.00
3/32	.09375	2.3813
7/64	.109375	2.7781
	.11811	3.00
1/8	.125	3.175
9/64	.140625	3.5719
5/32	.15625	3.9688
	.15748	4.00
11/64	.171875	4.3656
3/16	.1875	4.7625
	.19685	5.00
13/64	.203125	5.1594
7/32	.21875	5.5563
15/64	.234375	5.9531
	.23622	6.00
1/4	.2500	6.35
17/64	.265625	6.7469
	.27559	7.00
9/32	.28125	7.1438
19/64	.296875	7.5406
5/16	.3125	7.9375
	.31496	8.00
21/64	.328125	8.3344
11/32	.34375	8.7313
	.35433	9.00
23/64	.359375	9.1281
3/8	.375	9.525
25/64	.390625	9.9219
	.3937	10.00
13/32	.40625	10.3188
27/64	.421875	10.7156
	.43307	11.00
7/16	.4375	11.1125
29/64	.453125	11.5094

INCHES		MILLI-METERS
FRACTIONS	DECIMALS	
15/32	.46875	11.9063
	.47244	12.00
31/64	.484375	12.3031
1/2	.5000	12.70
	.51181	13.00
33/64	.515625	13.0969
17/32	.53125	13.4938
35/64	.546875	13.8907
	.55118	14.00
9/16	.5625	14.2875
37/64	.578125	14.6844
	.59055	15.00
19/32	.59375	15.0813
39/64	.609375	15.4782
5/8	.625	15.875
	.62992	16.00
41/64	.640625	16.2719
21/32	.65625	16.6688
	.66929	17.00
43/64	.671875	17.0657
11/16	.6875	17.4625
45/64	.703125	17.8594
	.70866	18.00
23/32	.71875	18.2563
47/64	.734375	18.6532
	.74803	19.00
3/4	.7500	19.05
49/64	.765625	19.4469
25/32	.78125	19.8438
	.7874	20.00
51/64	.796875	20.2407
13/16	.8125	20.6375
	.82677	21.00
53/64	.828125	21.0344
27/32	.84375	21.4313
55/64	.859375	21.8282
	.86614	22.00
7/8	.875	22.225
57/64	.890625	22.6219
	.90551	23.00
29/32	.90625	23.0188
59/64	.921875	23.4157
15/16	.9375	23.8125
	.94488	24.00
61/64	.953125	24.2094
31/32	.96875	24.6063
	.98425	25.00
63/64	.984375	25.0032
1	1.0000	25.4001

Precision Sheet Metal Set-Back Chart

MATERIAL THICKNESS

	.016	.020	.025	.032	.040	.051	.064	.072	.078	.081	.091	.102	.125	.129	.156	.162	.187	.250
1/32	034	.039	.046	.055	.065	.081	.102	.113	.121	.125	.139							
3/64	.041	.046	.053	.062	.072	.090	.108	.119	.127	.131	.145							
1/16	.048	.053	.059	.068	.079	.093	.110	.122	.134	.138	.152							
5/64	.054	.060	.066	.075	.086	.100	.117	.127	.138	.144	.158							
3/32	.061	.066	.073	.082	.092	.107	.124	.134	.142	.146	.160							
7/64	.068	.073	.080	.089	.099	.113	.130	.141	.148	.153	.167	.181						
1/8	.075	.080	.086	.095	.106	.120	.137	.147	.155	.159	.172	.186	.216	.221				
9/64	.081	.087	.093	.102	.113	.127	.144	.154	.162	.166	.179	.193	.223	.228	.263			
5/32	.088	.093	.100	.109	.119	.134	.150	.161	.169	.173	.186	.200	.230	.235	.270	.278		
11/64	.095	.100	.107	.116	.126	.140	.157	.168	.175	.179	.192	.207	.236	.242	.277	.284	.317	
3/16	.102	.107	.113	.122	.133	.147	.164	.174	.182	.186	.199	.213	.243	.248	.283	.291	.324	.405
13/64	.108	.114	.120	.129	.140	.154	.171	.181	.189	.193	.206	.220	.250	.255	.290	.298	.330	.412
7/32	.115	.120	.127	.136	.146	.161	.177	.188	.196	.199	.212	.227	.257	.262	.297	.305	.337	.419
15/64	.122	.127	.134	.143	.153	.167	.184	.195	.202	.206	.219	.233	.263	.269	.304	.311	.344	.426
1/4	.129	.134	.140	.149	.160	.174	.191	.201	.209	.213	.226	.240	.270	.275	.310	.318	.351	.432
17/64	.135	.141	.147	.156	.166	.181	.198	.208	.216	.220	.233	.247	.277	.282	.317	.325	.357	.439
9/32	.142	.147	.154	.163	.173	.187	.204	.215	.223	.226	.239	.254	.284	.289	.324	.332	.364	.446
5/16	.156	.161	.167	.176	.187	.201	.218	.228	.236	.240	.253	.267	.297	.302	.337	.345	.378	.459
11/32	.169	.174	.181	.190	.200	.214	.231	.242	.250	.253	.266	.281	.311	.316	.351	.359	.391	.473
3/8	.183	.188	.194	.203	.214	.228	.245	.255	.263	.267	.280	.294	.324	.329	.364	.372	.404	.486



DEVELOPED LENGTH = X+Y-Z

Z = SET-BACK ALLOWANCE FROM CHART

90 DEG. BEND RADIUS

4-27

123

Standard Tables and Symbols

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CRITERIA FOR PLACING HANDICAPPED STUDENTS IN REGULAR VOCATIONAL COURSES

Adapted from an Informational Brochure
Developed by Dr. Claire Szoke
for the Springfield Public Schools

A physical or mental handicap does not automatically mean that the student will be unable to function in a regular vocational course without special assistance. The ideal goal of vocational adjustment for the handicapped is participation in an occupation in which the mental or physical disability does not constitute a handicap. Thus, a student confined to a wheelchair might be classified as vocationally handicapped in a welding course but would be a "regular" student in bookkeeping. Social maturity and previous vocational skill preparation are also important.

Determination of the probable degree of vocational handicap is the first step in the placement process. The following criteria will be used to determine whether a student has the interest and ability to succeed in a regular vocational course:

* The student's behavior (as measured by judgements of teachers and counselors) is not a threat to either his own safety or that of others.
* Student expresses interest in course content.
* Recommendations of former and current teachers indicate probable success.
* Results of specially selected vocational aptitude and interest tests are positive. A number of such tests have been developed for poor readers. These include:

  Brainard Occupational Preference Inventory (Pshycological Corporation)--note: reading level is 6.4
  Picture Interest Inventory (McGraw-Hill)
  Bennett Hand Tool Dexterity Test (Psychological Corporation)
  Purdue Pegboard (Science Research Associates)
  Crawford Small Parts Dexterity Test (Psychological Corporation)
  Nonreading Aptitude Test Battery (revised version of the General Aptitude Test Battery; source local Illinois State Employment Service Office)

If physically and mentally handicapped students are to be successfully integrated into regular vocational courses, a careful matching of the student and an appropriate learning environment is essential. The following supportive services are ones that can feasibly be implemented in most public schools:

Materials

* Extensive use of audio visual aids: charts, films, slides, tapes, records, video tapes, overhead transparencies

* Written version of taped materials (hearing impaired)

* Taped versions of written instructional materials

  Mentally retarded or slow learners, e.g., students reading two or more grades below grade level:

  Retarded students who are very poor readers may have up to a sixth grade comprehension level if the material is in oral rather than written form. Sixth grade comprehension level is the level of many popular magazines, newspapers and television shows.

  Visually impaired

  Volunteer service agencies tape textbooks free of charge for the visually impaired -- they cannot do this overnight, however, but must have the text in advance.

* Taped versions of written tests and/or tests administered orally to the individual student (mentally retarded, slow learners, visually impaired)

* Large print versions of instructional material (visually impaired)

* Glossary -- at easy reading level -- of those vocabulary terms essential for the mastery of a particular course. Such a glossary should be used by students both in the vocational class and in their special needs English class. This reinforcement concept is especially valuable for the mentally retarded.

Resources

* Student note-takers (classmate makes carbon copy of his class "lecture" notes for hearing impaired student)

* Student teams (pairing special needs student with one or more non-handicapped classmates). If all the students in a class frequently work in pairs or small groups then the handicapped/disadvantaged student will not feel "singled out" for special assistance

* Individualized tutoring (out-of-class assistance by special education staff and/or special tutor, e.g., students from Sangamon State University; this service could, when needed, include a reader for the visually impaired or a person skilled in sign language to assist the hearing impaired student)

* Instructor aide

* Team teaching (special education teacher in class to assist regular vocational teacher; this is now being done in at least one Springfield Middle School)

CLASSROOM PROCEDURES HELPFUL TO THE SPECIAL NEEDS STUDENT

Mentally retarded or slow learner

* Emphasize hands-on experience.

* Use media (video tapes, films, filmstrips, overhead transparencies, charts, taped materials) to reinforce basic concepts.

* Use a variety of teaching methods -- some students have a short attention span. They will be happier and more successful if given several short tasks during an hour. If they need a lot of "drill" at a certain point, present it in a different way each time.

* Use task analysis, e.g., breakdown of a process into its component parts and the mastery of each task before moving on to the next stage.

* Allow ample time to complete a task -- some students take longer than others to perform a task. Rushing them will only make them more anxious and thus more likely to make errors.

* Emphasize the positive -- comment on what the student does right, rather than only pointing out errors.

* Keep required bookwork to a minimum.

Physically handicapped (orthopedically, hearing, visually impaired)

* Orientation: A small group orientation session should be held for the more seriously physically handicapped students prior to the first class. This orientation should be conducted jointly by the vocational teacher and a special education staff member. If possible, such orientation periods should be scheduled at a time when class is not in session. Such an orientation session should include:

    * Information regarding special equipment and resources available

    * Tour of the classroom laboratory to acquaint student with location of equipment and supplies (this is essential for the visually impaired)

* Opportunity for hands-on trial of basic equipment -- this will enable both the student and teacher to determine what adjustments might need to be made

A separate but similar orientation session should be held for mentally retarded students.

Hearing impaired

* Teacher and deaf student should cooperatively develop some simple signs.
* Be careful in using words with multiple meanings when talking to lip-reading hearing impaired students.
* Speak distinctly and slowly, use simple sentences, and look directly at lip-reading hearing impaired students.
* Emphasize demonstrations rather than verbal explanations.

Visually impaired

* Orderly workshop and individualized instruction regarding the use of each piece of equipment are absolutely essential.
* Give the visually impaired student ample time for accumulating finger knowledge -- teacher must aid student in moving fingers for gathering information.

SUGGESTIONS FOR EQUIPMENT MODIFICATION

Hearing impaired

* A red light installed next to the switch indicating when the machine is in operation
* Bells connected to a light that turns on when the bell rings; applicable on typewriters, class bells, timers, fire alarms, and emergency stop procedures

Visually impaired

* Control dials and switches that are easily accessible; special control dials with actual rather than visual markings; for this one can use brailled tape or raised marks (e.g., dots of Elmer's glue)
* Auditory rather than visual warning signals
* Guard plates (where feasible) on power equipment
* Specially designed measuring tools, e.g., audible multimeter, audible electronic level, brailled ruler -- see Aids and Appliances 18th ed., 1973, American Foundation for the Blind.

Orthopedically impaired

* Work tables which can be adjusted to various heights

* Semi-stationary equipment should be put on variable height bases.
* Sinks and water controls should be accessible to students in wheelchairs.
* Guard plates (where feasible) on power equipment; machine switches on power equipment may need to be moved for easier accessibility.
* Extra large handles on hand tools for easy use by students with weak hands

The following minor adptions which are desirable for orthopedically impaired home economics students are representative of quick, low-cost modifications which might be made or purchased for handicapped students in other vocational classes:

* Cutting board mounted on suction cups so that students with only one hand or with minimal strength would not have to be concerned with holding the board steady; peeling screw to hold vegetables to be peeled
* Electric scissors for students with minimal motor control
* Grocer's hook for reaching small items without the student's getting out of wheelchair
* Electric mixer with a level control instead of the dial-type speed control (also useful for the visually impaired)
* Place a lightweight sewing machine on a tray fitted over the arms of a wheelchair.

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